ON THE

HIGH ANTIQUITY

OF

IRON AND STEEL.

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In some previous communications to this Society * dealing with questions bearing upon the extremely archaic use of Iron and Steel, I ventured to bring together and discussed a variety of evidence in proof of the claims for Iron to be considered amongst the earliest, if not the very earliest of materials used by the human race, and that not in more or less recent periods merely, but notably that Iron was largely used in the most distant ages which we can with certainty fathom. Those claims, the evidence when candidly sifted, clearly asserts to be much stronger than what the archæologists had previously held; so strong, indeed, as to negative the popular and too hastily drawn conclusion, that man did not commence to use Iron until after whole millenniums of dealing with Bone, Stone, and Bronze.

The conclusions which I formerly gave expression to as having reached, from a re-sifting of the evidence, and also from having had further and more direct evidence to discuss, than, so far as I can gather, came under review of any of my predecessors in this particular field of research, although directly opposed to the views up to that time generally accepted, are now admitted by Egyptologists and those metallurgists who, having a safe foundation in the principles of a more or less exact science, have, of all persons who have approached questions bearing on the metallurgy of the ancients, and not bowing down to any particular theory, alone been able to deal with it in the spirit of a thorough understanding of certain essential conditions involved, and by correlating which is it alone possible that the Truth can be reached.

It would take far more time than we have now at our disposal to consider this subject in that complete manner which it so well

* Vide *Proceedings*, vol. vii., p. 476-488, and vol. viii., p. 235-268.

deserves, still more would it take to discuss all that other evidence which has with such surprising rapidity grown together, plainly indicating that in the East—whether it be among Semitic, Aryan, Hamitic, Sporadic, or Allophyllian races—the further back we reach, by so much do we receive proofs in the most ancient times of people endowed with a high practical acquaintance with the use of metals, and Iron, in particular, in its various forms of Malleable metal, Cast Iron, and Steel, prevailing and holding rule; we find, in fact, not a progressive rise in the qualities of materials used by man—that is to say, from those which are more or less soft and yielding, upwards to those which are necessarily harder and unyielding, still less for a time do we find a progressive retrogression; but what we in strict reality do reach as the ultimate outcome of our inquiry is an age in which a high civilisation, not a civilisation produced by culture, indeed, so much as a civilisation due to natural, innate Insight, rules—in which, to return once again to our immediate subject, all the metals, both noble as well as ignoble, precious stones and woods, are all together not only in full employment by the men of the time, but the very names for which are common words in all the oldest forms of language, whether in Egypt, Babylonia, Assyria, India, or even China. (See Table at the end.) The theory of a gradual transition by man in the use of substances progressively ascending from those which are comparatively soft and requiring but little skill to fashion to his necessities, up to those which are hard and unyielding and apparently needing a higher skill to utilise them, has in fact no foundation in those countries which were admittedly the earliest peopled; it is, in short, a conclusion which has been evoked in North-West Europe from researches for the most part dealing with evidence belonging to the Christian Era; and by virtue of those belonging to so comparatively recent an age, the inferences drawn are necessarily from a partial testimony, and therefore cannot be considered reliable.

But as is always the case in the pursuit of any subject outside the pale of pure mathematics, our first formed conclusions subsequently undergo modification, especially if founded upon what we had supposed at the time to be a complete array of facts, but which has later on received additions and perhaps correction; so in the present case, I am desirous to acknowledge and to correct some instances, not so much perhaps of actually wrong conclusions, but such as were fore-shortened and imperfect, at the same time to adduce further evidence which I have since collected, and which clenches as with an unyielding grasp, the arguments I formerly ventured to propound.

Yet before saying more, and in order to compress what I have now to add into the least space, and to make it as easily applicable to the former papers as possible, I shall follow, so far as practicable, the order in which the subject was treated of in them, by dealing with the earliest populated countries first, and then following the peopling wave as it spread in other countries, so far as our knowledge thereof will permit.

We will first, then, go back to Egypt.

EGYPT.

The difficulties in the way of deciding whether Iron was known to the Proto-Egyptians—to the men who erected in that country the earliest and most stupendous edifices of any age, and which they continued to erect, but always in a retrograding order, so far as dimensions and excellence of workmanship are concerned, from the Delta southwards, for about 1600 years—were insuperable, until in the first place Colonel Howard Vyse's Engineers removed by blasting from the oldest and largest building there, nay, in the entire world rather, the piece of Iron now in the British Museum, and which is illustrated by a plate in the seventh volume of this Society's *Proceedings;* and in the second place, the reading of the hieroglyphs became so far advanced, that it enabled the mention of that metal to be detected in some inscriptions belonging to the third dynasty of Memphis, to which I shall presently refer. Since the occasion, when, nearly four years ago, I directed the attention of this Society to the existence of this very unique specimen of some primeval Oriental smith's handiwork, there have not been wanting those who have raised certain doubts respecting it, and these based partly on the difficulty of accounting for a sufficiently actual Egyptian source of Iron ore to produce the metal in the quantity in which it must have been required, if it is once granted that the early Egyptians knew of Iron or even used it at all. I had certainly from the first held this difficulty in full view, and never felt satisfied regarding it until ascertaining* the existence of Iron in the Egyptian limestone, and the manner in which it accumulates in fissures, as set forth in my second paper. (Vide *Proceedings,* vol. viii., Dec. 4, 1872.) Yet that answer to the difficulty, whilst deemed satisfactory at the time, sinks into insignificance when placed against the immensely extended and incontrovertible proof since brought to light by Mr. Hartland.

* From information kindly furnished by the Astronomer-Royal for Scotland.

It is many years since Mr. Francis Galton found a black-looking slag in some exceedingly ancient Sinaitic remains, conjectured to be anterior to the time of Moses;* but it is only quite the other day that the import of this first step in a discovery received its due weight, and was consummated by the further finding of vast Iron-works by Mr. Hartland, in the neighbourhood of that part of the Sinaitic peninsula which was held in subjugation by the kings of the third and fourth dynasties of the old empire reigning at Memphis, as proven by the monumental tablets in the Wady Meghara.

To this discovery I shall presently recur; but before dwelling upon it, it is important to shew that the prior discoveries of the mention of Iron in some of the earliest hieroglyphic tablets left it more or less probable that such allusions or references as are found in these lithic writings might at some future time be corroborated by the discovery of relics of the actual Egyptian Iron manufacture; and on the other hand, the finding of such remains is proof again that the hieroglyphic readings, even with the halos of uncertainty which in respect of the metals have until quite lately surrounded them, and which have been so fully acknowledged by Lepsius,† are, if not precisely so, at least very approximately correct.

At page 487, vol. vii. of the *Proceedings*, I mentioned that the oldest known Egyptian word for Iron in one of the dialects was Benipe; in another dialect the initial B is commuted to P, and the word becomes Penipe, as I have been since informed by Lepsius.

On turning to the *Dictionary of Hieroglyphs* we find, without an explanation, however, being given, by which an intelligible view of the position may be gathered, all the annexed hieroglyphs, with the phonetic values marked for this one substance, in the order in which they are here set down. (See Table on next page.)

Evidently, then, assuming for the moment that the phonetic values are correct as given by Dr. Birch, it may be said that Ba is a constant in those phonetic values which have been assigned to hieroglyphs translated as Iron; but this is a point leading into the most subtle intricacies of the science of language when truly and genuinely followed, the Egyptian *ba* corresponding, I am strongly inclined to believe, to what we find in the χαλκός of Homer, to which an exact value is frequently given by the coupling of an adjective, such as ἐρυθρός, red; αἰθωψ, black, &c.

* Percy's *Metallurgy*, 1st edition, page 874.

† *Die Metalle in den Ægyptischen Inschriften*, Von C. R. Lepsius, aus den Abhandlungen der Königl. Akademie der Wissenschaften zu Berlin, 1872.

TABLE.

Hieroglyphs.	Phonetic Value.	Translation.
	Ba.	Earth, Metal.
	Ba.	Iron.
	Baá.	Iron, Earth.
	Baáenepe.	Iron.
	Bet.	Iron.

Indeed, this view has been strengthened from a recent conversation with Dr. Birch, in which he informed me that, agreeing with Lepsius, the rendering or phonetic value of the hieroglyphic symbols for Iron is still very uncertain. On November 6th, 1874, when at the British Museum, Dr. Birch expressed to me his belief that the first syllable Ba was a general term, signifying metal, and a particular metal was denoted by the use of prefixes signifying its qualities, such as white, black, yellow, &c.

Whilst, then, in the Sahidic dialect, which is said to be the oldest, we have the word *B*enipe, and in another Egyptian dialect *P*enipe stands for Iron, or the initial B and P are commutable; this change corresponds to what we find in the Hebraic and Chaldee tongues, where in the former we have *B*arzel, in the latter *P*arzel.

Again, with further reference to the old Egyptian word for "Iron," it appears to have been proved, according to another statement by the Rev. Basil H. Cooper,* that the sixth successor of Menes, or the seventh king of Egypt, bore in the royal oval or cartouche containing his name the very word "Benipe." His name was "Mibampes."

"Nine years ago," says the Rev. Mr. Cooper, "the name of this monarch was only known from Manetho and Eratosthenes, in both of whose lists of kings it appears in a more or less corrupted form.

* *Antiquity of the Use of Metals, especially Iron, among the Egyptians*, page 18. Reprinted from the *Transactions of the Devonshire Association for the Advancement of Science*, &c., 1868.

The royal oval or cartouche of this king does not appear in the tablet of Karnak, nor on the old tablet of Abydos, nor has it been detected on any isolated monument; but towards the end of 1864, when the tablets of Saqquara near ancient Memphis, and the new tablet of Abydos were published—the former having been discovered by Mariette Bey, and the latter by Herr Dummichen—this 'Iron King's' name was brought to light."

"On the tablet of Saqquara, or Memphis, which, like the old tablet of Abydos, belongs to the reign of Rameses the Great, say about the thirteenth century before the Christian era, the Iron King is actually the first of the fifty-six ancestors of Sesostris, whom the tablet originally comprised, and nearly all of whose escutcheons are still very well preserved. In the new Abydos tablet he stands sixth, one king being omitted in the interval, as we learn from the invaluable Hieratic Canon of the Pharaohs preserved in the Turin Museum, in which priceless document the discovery of the new tablets at once enabled Egyptologists easily to spell out the name, which had previously been undecipherable. In all the three hieroglyphical records the name reads distinctly, 'Lover of Iron'—of course meaning, 'Lover of the Sword'*—thus attesting not only the extreme antiquity of the use of Iron, but unfortunately also of that most dreadful evil of all which are the scourges of humanity, war."

But the evidence on behalf of early Iron-working in Egypt does not terminate with the mention thereof in the Inscriptions.

We will now consider the important discoveries of Mr. Hartland, already alluded to. In the early part of 1873 Mr. Hartland described to the Society of Antiquaries his visit to Ayûn Mûsa (the Wells of Moses), by the Red Sea, the Wilderness of Sin, the lonely march of three days across the parched desert to the palm-tree groves of Wady Gherundel, and the defiles leading to Sinai. Mr. Hartland has built a house, in order to carry on his researches, near the junction of the Wady Kemeh, the Wady Mukattab, or the Written Valley and the Wady Meghara, and having taken some of

* This may possibly be one and a true rendering of the title, "Lover of Iron," but that it is the whole meaning involved under it, I think, may be seriously questioned, for we must remember that all art, and especially architecture, or the expression in material form or by sculptured symbol of all that was highest and deepest in man, could not receive such expression in well dressed and accurately finished stone, until the material for furnishing instruments for acting thereon was acquired; so that it is clear King Mibampes may well have been a "Lover of Iron," without necessarily being a warrior. – St. J. V. D.

the friendly tribes into his pay, has succeeded in discovering the old turquoise mines of the ancient Egyptians, the rocks that they worked for these stones, and it is said the very tools they used, also the places where they ground and polished these stones. This, however, is incidental, and but leading up to the other discovery, which is of so much importance to the subject of this paper; for, whilst investigating in other directions, Mr. Hartland has come upon the remains of Ironworks. These works stand adjacent to the mines on some hills, at a place called Surabit-el-Khadur, and were constructed on the Catalan system, in the opinion of their discoverer. The ore was very imperfectly extracted—slag brought over to this country, from the immense heaps that like mountains are piled around, contains as much as fifty-three per cent. of Iron. These works were commenced in very early times; each Pharaoh, as he continued them, added a large engraved stone, not unlike our tombstones, to state his work.* "It is to be hoped," remarks the author of the paper describing this unique discovery, "that rubbings of these stones may be sent to some of our skilled readers of hieroglyphs, since much valuable historical information respecting the Egyptian metallurgy may have been by them preserved for our enlightenment, and to shew how little the mind of civilised man has developed during 3000 years."

It is further explained by the writer from whom we have quoted the preceding passage, that the district where this unique discovery has been made "has remained unexplored, probably on account of its being off the beaten track; and in an unknown country there is no temptation to stray, particularly as the guides and dragomen discourage any explorations which may add to the risk of the journey."

Besides the ruins of these works and the enormous slag heaps near them, there also exist the ruins of a temple and barracks for soldiers to protect them.

Yet what is more remarkable still, as opposing the modern North European theory of the succession of Stone, Bronze, and Iron ages, is the solid fact that in this temple at the Sinaitic Ironworks, Mr. Hartland found Flint Arrow-heads, which he has presented to the Society of Antiquaries, and which he describes as being the earliest known specimens in the world. It is, of course, possible that the discovery of Flint Arrow-heads side by side with Iron is a mere coincidence, and that the two may be of a different age; but if a mere coincidence, it is not possible, under the circumstances of their

* Vide *Proceedings, Soc. Antiq.*, Vol. v., 2nd Series, June, 1873.

being found not buried deep down in the earth, but in or among the very ruins of the barracks, that they are older than the barracks or Ironworks themselves: they may be coeval therewith, but it is not impossible, nay, it is extremely probable that they are relics belonging to some long subsequent age (in which, as we know to be the fact, the Egyptians had retrograded from their lofty initial standard of excellence in mechanical art), or that they may belong to some inferior foreign race who settled in or swept over the peninsula in a later period. The latter view has a strong probability of being true; for, as we learn from Dr. Schliemann's researches into the mound of Hissarlik,* whether that be the veritable site of the Ilion of Homer or not, the fact is undoubted, that whatever the ruins there covered may be, he finds four cities successively buried and built on one another, and in all of them Flint and Stone implements side by side with Copper, Bronze, and oxidised Iron in abundance; and notably in the fourth uppermost or most recent stratum, where the Flint implements are most abundant, they are there associated with what his English editor describes as primitive wooden buildings, not found in the lower ruins, where everything, and especially architecture, teems with excellence. With respect to Iron in the Hissarlik remains, Schliemann rather significantly remarks—"The only objects of Iron which I found," excepting the sling bullets in the lower stratum, which have been analysed by M. Damour, "were a key of curious shape, and a few arrows and nails close to the surface. From Homer, we know that the Trojans also possessed Iron as well as the metal which he calls κύανος, and which, even in antiquity, was translated by χάλυψ (Steel)." Steel, however, he does not appear to have found; yet Dr. Schliemann adds, "Articles of Steel may have existed. I believe positively that they did exist; but they have vanished without leaving a trace of their existence; for, as we know, Iron and Steel become decomposed much more readily than Copper"—in respect of all which the editor of the English translation, Philip Smith, with a salutary and gratifying warning, adds—"Such facts as these furnish a caution against the too hasty application of the theory of the ages of Stone, Bronze, and Iron;" and whilst I have made mention of the Hissarlik finds as representing almost, if not quite, a parallel to the association of Flint knives with the Sinaitic Ironworks, I have done so with the view of fairly interrogating every side of the question, so that others may discuss it at once from each point of view; yet I think that the weight of evidence will be allowed as decidedly in favour

* *Troy and its Remains.* By Dr. Henry Schliemann. London, 1875.

of the conclusion expressed by Mr. Hartland, that the Flint implements of the Sinaitic Ironworks are the oldest relics of the kind yet found; and in the light of all circumstances involved, the probability is, that they are as old as the Ironworks also, so that in any view of the case we have Ironworks at least as ancient as the Flint Arrowheads, and probably much more ancient. In this connexion, I may further remind you that the Abbé Richard has pointed out the discovery of Flint implements in Egypt, Mount Sinai, Galgala, and in the tomb of Joshua* at Timnath-Serah in Mount Ephraim, from which it would seem almost certain that the Hebrew race, both when in their wanderings in these lands, and after crossing the Jordan, who we know were familiar with the use of Iron, also used implements of Flint; therefore, as the Sinaitic Ironworks now discovered lay right in their track, the Flint Arrowheads brought home

* Paper read before the British Association in Edinburgh, 1871, and in respect of which it may prove useful to quote the following from a recent French work, *La Terre*, by M. Pozzy:—

"'Ce fut au pied du Sinaï biblique, dit-il, que je trouvai le plus grand des ateliers de silex que j'aie encore vu, avec les spécimens les plus remarquables et surtout des pointes de flèches extrêmement fines. La plus jolie a été trouvée dans l'Ouadi Férou, au centre même des montagnes sinaïtiques.

"'Vinrent ensuite plusieurs instruments trouvés en Palestine, à Elbireh, à Tibériade; et entre le mont Thabor et le lac de Tibériade, sur un plateau élevé de plus de 250 mètres au-dessus du Jourdain, dans un champ cultivé, une hache semblable, quant à la nature du silex et à sa forme, à celles de la Somme.

"'Mais les instruments qui méritent, je pense, la plus grande attention sont ceux que j'ai trouvés sur le bord du Jourdain, à Galgal, lieu où, d'après la Bible, Josué reçut l'ordre de Dieu de circoncire le peuple d'Israël, et dans le tombeau que la science archéologique regarde aujourd'hui comme le tombeau de Josué. J'ai trouvé ces instruments soit dans le tombeau même de Josué, dans la chambre sépulcrale intérieure, soit dans le vestibule, mêlés à des débris de poteries, à de la terre, etc.

"'J'en ai trouvé aussi dans le champ qui est devant le tombeau et jusque sous un grand chêne vert éloigné de la tombe de Josué d'environ 70 à 80 mètres; ils avaient éte ainsi disséminés, quand on a fouillé et violé le tombeau.

"'C'est la forme communément appelée *couteaux* qui domine dans ces instruments; quelques-uns, comme on peut s'en convaincre, sont encore très-tranchants. Il y a cependent des scies, des pièces plates et arrondies, etc. La plupart sont du silex; il y en a aussi en calcaire blanchâtre qui semble avoir passé au feu.

"'J'ai l'espoir, continue M. l'abbé Richard, que ces *instruments du tombeau de Josué* et ceux dont j'ai parlé d'abord intéresseront les amateurs si nombreux et si éclairés de l'archéologie humaine que l'Association compte dans son sein; et en les soumettant à votre appréciation, je viens vous apporter non pas des idées préconçues, non pas des théories, mais des faits, de simples faits historiques et archéologiques.

"'C'est un fait historique que la fabrication de couteaux de pierre pour la circoncision des enfants d'Israël à Galgal, non loin du Jourdain. C'est un fait historique que le tombeau de Josué, élevé non loin de Sichem, longtemps oublié

by Mr. Hartland, it is pretty nearly certain that if they belong to a later date than the works themselves, are relics of the forty years wanderings of the chosen race.

To return. Far, indeed, is it from my wish to influence an over-estimate of the importance of this the latest of Egyptian "finds;" but it seems to me very necessary, indeed, to point out that the discoverer, and those who have already written on the discovery, place the age of these Ironworks at too low a date, and for this reason, that they happen to be in the actual neighbourhood in which have been found monuments at least contemporary with and by some computed to be older than the oldest of the pyramids —certainly as old as the fourth, if not the third dynasty of Memphis.

ou perdu, a été retrouvé, et que ses restes ont été vus et décrits par MM. de Saulcy, Guérin, etc. C'est un fait historique attesté par la version authentique des Septante qu'un certain nombre de couteaux de pierre de Galgal ont été projetés dans le tombeau de Josué, au moment de sa sépulture.

"'M. de Saulcy, dans son *Voyage en Palestine*, n'avait pas hésité à dire, dans sa confiance absolue au récit des Livres saints, que ces couteaux de pierre devaient exister encore dans le tombeau retrouvé de Josué. Mais l'abbé Moigno, mon illustre ami, dans son journal *les Mondes*, avait rappelé l'affirmation de M. de Saulcy, et m'avait vivement pressé d'aller, pendant que j'étais en Palestine chercher ces silex. J'y suis allé et je les ai trouvés.

"'Quant aux conclusions que l'on peut tirer de mes instruments, aux arguments qu'ils peuvent apporter ou aux objections qu'ils fourniront contre les théories mises en avant par les diverses écoles anthropologiques ou biologiques modernes, je les laisse de côté.

"'Si mes silex historiques ressemblent à s'y méprendre, par leur nature et leur forme, aux silex que l'on veut être essentiellement *préhistoriques*, je pourrai le regretter, au point de vue des illusions que cette coïncidence peut faire évanouir, mais la vraie science doit accepter les faits, et reconnaître l'identité des silex *préhistoriques* et des silex *historiques*.'

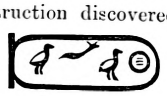
"Le 29 du même mois, M. l'abbé Richard présentait ses silex à l'Académie des sciences de Paris, et dans un compte rendu de cette séance paru au *Moniteur universel* les mêmes faits ci-dessus relatés étaient reproduits.

"De ces faits il résulte, comme nous le disions tantôt, *que les âges de la pierre, du bronze et du fer n'ont pas toujours été successifs, mais quelquefois simultanés.* Il n'est pas douteux par exemple qu' à l'epoque où l'officine de silex taillés était en grande activité, au pied du Sinaï, l'usage du fer était depuis longtemps connu en Egypte. Quand, au pied de ce Sinaï, Dieu menace les enfants d'Israël, en distant: 'Si vous ne m'écoutez point, je ferai que le ciel sera pour vous comme de fer, et votre terre comme d'airain' (Lév. xxvi. 19), qui peut douter que l'usage du fer et de l'airain ne fût connu des Israélites? Quand, après une victorie sur les Madianites, Moïse dit que 'l'or, l'argent, l'airain, le fer, l'étain, le plomb . . . , soint purifiés par le feu' (Nomb. xxxi. 22); quand le livre de Josué parle des chariots de fer des Cananéens (Josué xvii. 16), n'est-il pas évident qu'on connaiséait alors tous ces métaux? Quand, vers la même époque, Job nous dit 'que le fer se tire de la terre' (Job xxviii. 2); quand il s'écrie: 'Plût à Dieu que mes discours fussent gravés avec une touche de fer et avec du plomb, et qu'ils fussent taillés sur une pierre de roche à perpétuité!' (Job xix. 24) ne sommes-nous pas autorisé à tirer la même conclusion?"

I allude to the celebrated Wady Meghara tablets * of the third and fourth dynasties; whence it may be inferred as most probable that we are not far off from, if not actually at, the very source of the Iron and Steel from which the tools were formed to hew and dress the mighty stones of old Egypt's mightiest and oldest monuments. Nay, and until some one shall prove to the contrary, that we have reached the actual forge whereat some primeval smith wrought that one alone known relic of pre-historic Iron-working which has descended to us—itself happily preserved in the treasure-chest of the Anglo-Saxon nation, the British Museum, and amongst all the contents of which there is nothing else which, when followed out *à fond* is capable of teaching a lesson so real, so contrasting—shall we say there is nothing else so *iron*ically vocal from the ages of the old world?

There are, moreover, other facts which seem to render it certain that the foregoing inferences represent the true state of the case, and to which I now direct attention.

No fact is better known than that oft-repeated one, that the oldest architectural monuments in the world are the pyramids and tombs of Ghizeh. Another fact is equally well known, that the question as to how or by what instruments the not only large but intensely hard stones of some of these works were quarried, cut, and dressed into shape, with the exquisite finish we find them possessing in many cases, even now, has never been solved. There are no remains of Ironworks in the neighbourhood of Memphis or Ghizeh, nor in any part of Egypt, nor in the Sinaitic peninsula as yet discovered, other than those we have already alluded to in the neighbourhood of the Wady Meghara. From the tablets in this remarkable valley, we find undoubted evidence of a king of the third dynasty of Memphis at war with and subduing the inhabitants in the Eastern frontier of Egypt. His name was Sephuris, and in the lists of Manetho he is the eighth king of the third dynasty, and the very earliest monarch respecting whom we possess contemporary evidence. His name, Fig. 1, occurs in an inscription

* The cartouches of the same kings are found in the rock tablets of Wady Meghara, as well as in the chambers of construction discovered by Colonel Howard Vyse in the Great Pyramid - namely,  Shofo, and  nu-Shofo and this fact is strong evidence of their contemporaneousness.

over the doorway of a tomb at Ghizeh, which, the inscription tells us, is that of his own son, whose death occurred in the lifetime of his father. This same name occurs again on a rock tablet in the Wady Meghara, as shewn at Fig. 2, which is a copy from Lepsius. Sephuris is here accompanied, says Osburn, "by his standard or title, *i.e.*, the great Horus (*Aroeris*), lord of justice." . . . . "It seems to have been a war flag. The rock-inscribed tablet whence we have extracted it represents Sephuris holding a foreigner by the hair, and in the act of smiting him with a club or mace. He is called 'SEPHURIS, the great god, the subduer, conqueror of countries.' Like many of his followers, Sephuris was called upon to defend the Eastern frontier of Egypt against foreign aggression. He first recorded his successes on the rocks of this desolate valley, and they have followed his example." *

Fig. 1.

Let us observe, that, as belonging to the time before which Sephuris had vanquished his Eastern foes, Egypt has not yielded a certain trace of a single contemporary monument of any kind; that before his time all is traditional *and absolutely devoid of collateral support*, although we believe that it has been thought by some that the mention of Aches, the seventh king of the third dynasty, in a tomb at Abooseer, and which Rosellini also found in another tomb at Saqquara, render it probable that these may be a little older than the reign of Sephuris; but even allowing this full weight, it is trifling and unimportant in comparison with what we find occurring at Memphis after the conquests of Sephuris in countries to the east of Egypt.

The oldest inscriptions are those in the Wady Meghara, in the very neighbourhood where the ruins of vast Ironworks have now been discovered by Mr. Hartland; and is it surprising, then, or rather is it not exactly what we should expect on *á priori* grounds, that there are no inscriptions nor monuments to be found until we come to the very time in which and the site whereat the gravers, the chisels, and other instruments necessary to the inscribing and otherwise working in stone were manufactured, these being even depicted on the very oldest tablets (see Figs. 2 and 4 especially), and that so soon, immediately, in fact, that we find a source for such tools, then we find the rock inscriptions and built monuments produced by their aid in abundance, extending thence through all the active period of Egyptian history?

* *Monumental History of Egypt*, Vol. i., 254-5.

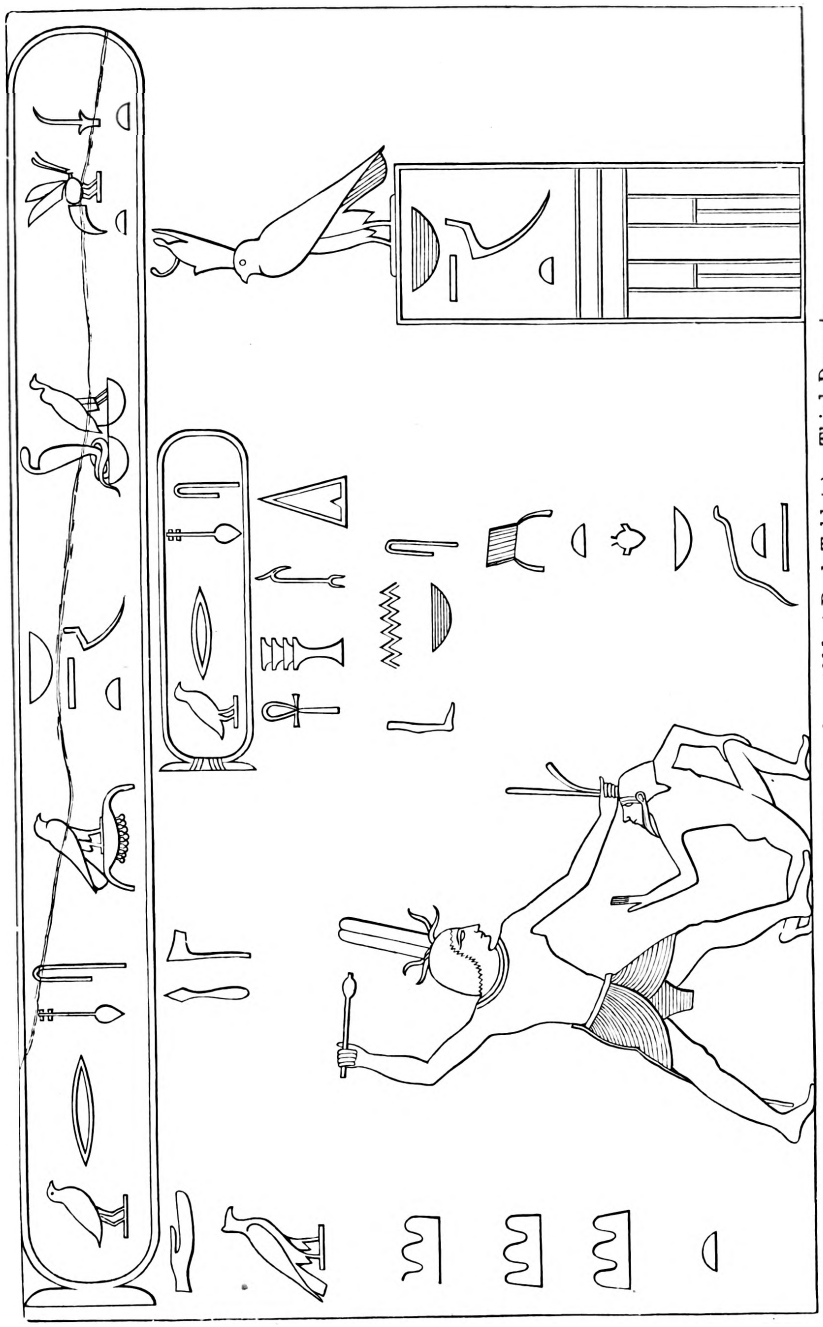


Fig. 2. Sephuris at Wady Meghara (Oldest Rock Tablets). Third Dynasty.

We have to remember, too, that the early colonists of Egypt came thither from Mesopotamia, a vast plain of sand, mud, and clay, where the buildings were erected of sun-dried bricks, and the necessity for Iron was on that account extremely limited as compared to that of another region wherein nature had provided the obdurate rock to be dealt with; also, that for the first two, and probably up to the seventh king of the third dynasty, the Mizraites confined themselves more or less closely to the banks of the Nile, at and about the Delta,* which is also of a Mesopotamian character, so that, as in their fatherland, these Mizraites during that period, and until they began to penetrate the country or were attacked by warlike neighbours, were not likely to feel the want of instruments or weapons of Iron, but in all probability continued to construct such temples or houses as were raised above the ground-level, of bricks dried in the sun and formed of the clayey mud of the Nile, as their forefathers had taught them in Shinar.

After the death of Sephuris the countries to the east of Egypt were still maintained under the yoke of the kings of Memphis. Accordingly, we find in the Wady Meghara a succession of rock-cut tablets, with the names of their successive Memphite kings, and the kings themselves depicted in the act of keeping the people in subjugation. Reference is now made to Fig. 3, respecting which we read—"Like his predecessor Sephuris, Soris had also to defend his north-eastern frontier against the desert rangers of Sinai." The subjoined tablet, Fig. 3, is inscribed on the barren crags of the Wady Meghara. It reads—"[HORUS], the hawk divine and great, the mace in all the lands of Monthra,† the subduer of all lands." The personage here discoursed of is the prince who holds his enemy by the hair, and smites him with the mace. This portion of the tablet refers to some military achievement accomplished in this neighbourhood by Soris when a prince. The rest of the tablet commemorates Soris as a king. It reads—"The lord of the festivals, King of Upper and Lower Egypt, Soris, ever-living." The two figures below represent Soris as King of Lower and Upper Egypt—

* It is, indeed, yet unproved that there were any actual buildings in Egypt constructed by native Egyptians until after the first Hyksos Invasion (commonly called the Shepherds), when that Shemitic community erected, or rather prevailed upon the monarch Shufu to erect, under their leader's superintendence, at the apex of the Delta the oldest building of all—the Great Pyramid. There was, however, plenty of excavation in the living rock, but nothing of architecture proper that we have yet ascertained.

† The God of War.

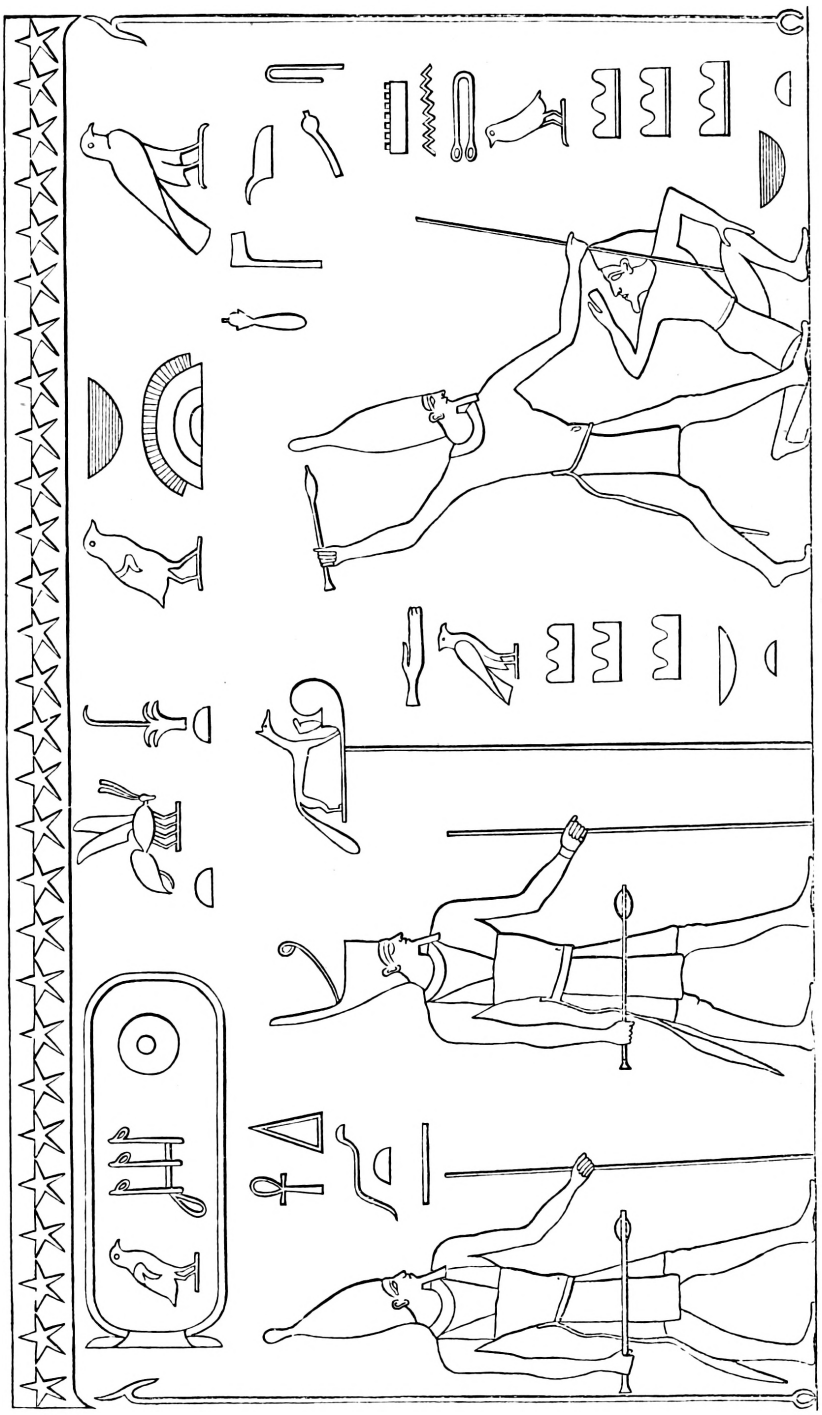


Fig. 3. Soris and the Canaanites at Wady Meghara (Oldest Rock Tablets). Fourth Dynasty.

i. e. of both banks of the Nile, in token of which dignities he wears the red and white portions of the *shent.* Immediately in front of him on a standard is the jackal, the symbol of vigilance. Above him are the starry heavens, supported by two sceptres, with the head of the Hoopoe, the symbol of purity.

That Soris reigned twenty-nine years, and that he was the first of a dynasty of Memphite kings, are the only particulars regarding him preserved in the lists.

Soris was succeeded by Suphis; and Fig. 4, also a rock tablet from Wady Meghara, represents him holding his enemy by the hair, and about to fell him with the weapon which he holds raised in the other hand.

Until the reign of Suphis there is no architectural monument to record—we mean in the sense of a built edifice; but in his reign and the co-regent reign of himself and his brother Nu-Shufu, we find ourselves suddenly confronted with the Great and Second Pyramids of Ghizeh; and whilst the existence of these, apart from any evidence of their actual growth from smaller and more imperfect preceding examples, has always been as great a puzzle to the inquirer as the solution of the question—By what means or tools the work of their construction was effected? I hope, at least, to have helped to clear the path of difficulty by having traced out almost to a certainty that Iron tools were supplied from the neighbourhood of Wady Meghara, which was held by the Memphite kings at the time the oldest monuments were erected; and the additional circumstance that they were held by force of conquest is not only testified by the Meghara tablets themselves, but also by the existence of the ruins of a vast fortress in the neighbourhood of the Ironworks.

Since the evidence in favour of an extremely remote use for Iron in Egypt has come to light, and bearing in mind that the Greeks were acquainted with the manufacture of Steel, as described by Aristotle, some persons have even ventured so far as to suppose that the find of Col. Howard Vyse's Engineers may probably be Steel also. I must confess that when at first, at the recent Congress of Orientalists, held last year in London, this was suggested to me by Dr. Lepsius, I paid but little heed to it; but when he especially directed my attention to the shape of the relic and its appearance, pointing out its being somewhat thick along the middle and tapering off as if to an edge on either side, after the manner of a scraper, for finishing and finally levelling the outer faces of dressed stone, I became impressed with the force of that great Egyptologist's suggestion.

A familiarity with the accepted methods of testing metals

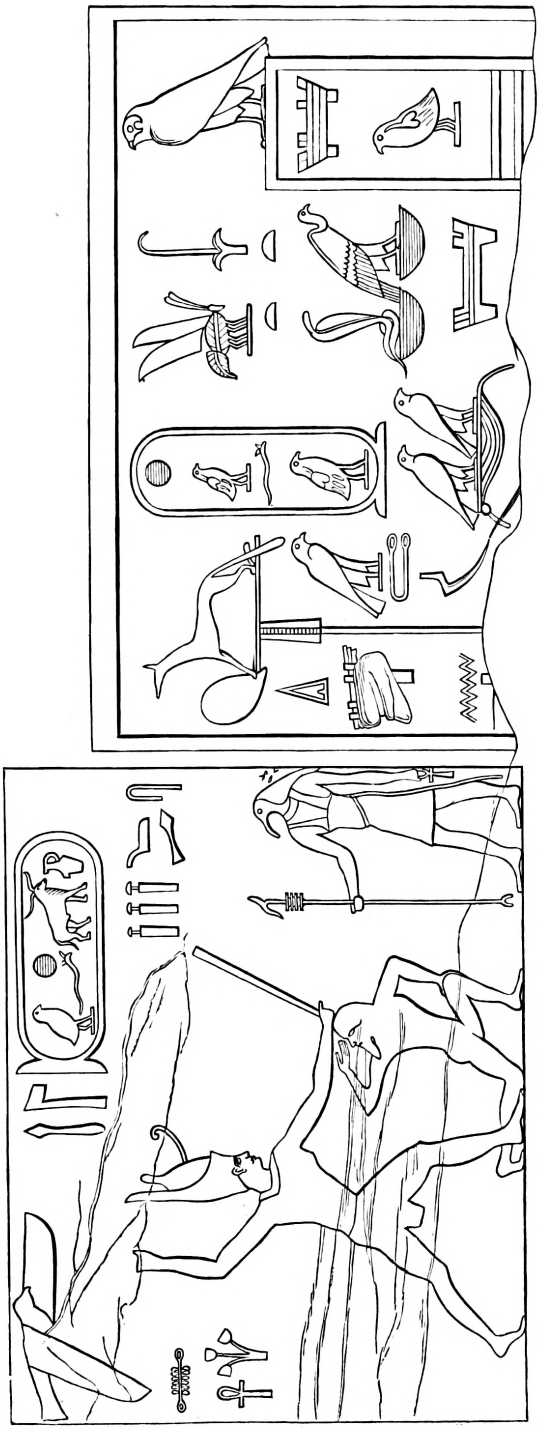


Fig. 4. Tablet of Suphis and Nu-Suphis at Wady Meghara. Fourth Dynasty.

naturally suggested to me that the question as to whether the relic was of Iron or Steel might, with a close approximation to certainty, be tested, by attempting to drill a hole in it, the relic, although much oxidised, being still for the most part in the metallic state. The conclusions to be drawn from such a test are, that if the drill easily and quickly penetrated the metal, then it must be Iron; that if, on the other hand, it resisted the action of the drill altogether, it was hard Steel; or if the drill penetrated but slowly then it was probably softer Steel. The writer having explained the proof which such a test would afford in ascertaining the character of the relic to Mr. Bonomi and Dr. Lepsius, they prevailed on Dr. Birch to consent to the writer drilling a hole in it, and in the presence of those interested the test was made on the 18th of September 1874, at the British Museum.

Having scraped off a little of the oxide near the thicker part of the fragment, the author commenced drilling, and finding that with a few rotations the drill easily penetrated the metal, he was at once convinced that it was soft Iron; the drilling was continued, but at the request of Dr. Birch the hole was not put through the Iron. The surfaces of the hole were examined, and had all the appearance of brightness and whiteness characteristic of newly-cut malleable Iron. To record the examination which has now been described, the following memorandum was drawn up by Dr. Birch, and signed by those who witnessed the test :—

"British Museum, 18*th September*, 1874.

"An examination by drilling of the fragment found near the channel of one of the air passages of the Great Pyramid, in the excavations undertaken by Colonel Howard Vyse.

"It was found that the fragment was of Iron, the drilling having penetrated it.

(Signed) S. Birch.
St. John V. Day.
R. Lepsius.
Chas. Seagar.
J. Bonomi."

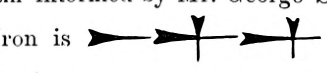
As the conclusive value, however, of a mechanical test may be called in question, it seemed desirable, that it should be confirmed or negatived by chemical evidence, and it was mentioned to Dr.

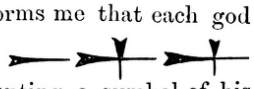
Birch, that a chemical analysis should also be made. On Dr. Birch's suggestion, I have represented to the Trustees of the British Museum the importance of knowing the chemical constitution of the relic, and that body has responded to my representation by instructing Dr. Flight to analyse it. As yet I have not received a report of the analysis, but when I do so I shall hope to communicate it to the Society.*

MESOPOTAMIA.

In the second paper on this subject read to this Society, I dwelt as far as was then possible on the use of Iron by the earliest inhabitants of that Interamnian plain, watered on one side by the Tigris, and on the other side by the Euphrates. Since then Mr. George Smith has carried out his excavations into the mounds there, and these have been productive in bringing to light several specimens of ancient Iron; none of them, however, are older than from 800 to 1000 B.C., yet I may be permitted to mention them, and in particular to refer to the Ombos of a shield as the most exquisite piece of ancient Ironwork I have met with—as a specimen of thin hammered Ironwork, I doubt if it can, in some respects, be surpassed by the productions of to-day.

Yet whilst Mesopotamia has not up to the present time produced any solid evidence in the form of material Iron relics belonging to the *oldest* monarchies, nevertheless the monuments of those earliest times are numerous, and they yield abundance of testimony to the acquaintance of the contemporary people with Iron.

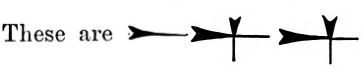
I am informed by Mr. George Smith that the cuneiform symbol for Iron is  but that its phonetic value or pronunciation is not yet determined. It is found in inscriptions of all ages, and Mr. Smith says "must have been in use 2000 B.C." This, however, he informs me is not an Assyrian word, but one distinctly belonging to the ancient Babylonian or Proto-Chaldean people who inhabited the lower parts of the plain. There is, in fact, no pure Assyrian word for Iron, but this older one appears to have been grafted into the more recent Assyrian language.

In the inscriptions Mr. Smith further informs me that each god is mentioned with his sign, and this word  is the sign of one of the gods of war and hunting, a symbol of his particular god-like attributes, a parallel indeed to the symbols we

* *Vide* Appendix, page 34, which has been received since the reading of this paper.

have found in the cartouche of the Iron King of Egypt, in the third dynasty of Memphis. Whilst on the one hand, then, Mr. Smith denies the discovery as yet of the phonetic value of this Proto-Chaldean symbol, on the other hand it should be mentioned that Professor George Rawlinson, of Oxford, has many years since published the word "*Hurud*"* as the Chaldean equivalent for Iron, but whether he gave this as the phonetic value for  I have until recently been in doubt. Uncertainty on that question is however now removed by the following statement in regard to the cuneiform signs, with which I have within the last week been favoured by the Rev. George Rawlinson, who, writing from Canterbury, says:—

"I delayed answering your letter until I could consult my brother on the subject, as I was not quite certain with regard to one or two points. I am now able to give you the benefit of his superior knowledge.

"There are two signs of metals in Assyrian with respect to which there is a doubt, which is Iron and which is Brass (or Bronze rather). These are  and  . My brother on the whole inclines to regard  as Bronze and  as Iron. The former  is nowhere rendered phonetically, but the latter  is rendered in a syllabary as equivalent to *hurud* in Akkadian and *eru* in Assyrian. Mr. George Smith reverses the meanings of the two signs. The point is a very doubtful one."

CHINA.

Let us now then turn from those regions of the Old World, which are comparatively near, to those which are easternmost and vastly further removed from our ability to investigate. In a former paper † I drew attention to the extreme scantiness of our information respecting the state of the mechanical arts in China in very ancient times, but the labours of the Tsinologues in un-

* Vide *Five Great Monarchies of the Ancient Eastern World.* By Professor Rawlinson. London, 1871, vol. i., p. 62.

† Vide *Proceedings*, vol. viii., p. 24-7.

ravelling to the European mind the riches of that store of highly archaic literature which China possesses—a secular literature certainly as old, in all probability very much older than what is to be met with in any other country, asserted indeed to be at least 500 years older than the Hebrew Scriptures—have at last dispelled all doubt on the question, whether in China the use of Iron was known in pre-historic times. But this is not all, for in the most ancient Chinese writings mention is made of Steel, and Leih-Tze, an author who flourished about 400 B.C., describes the process by which it was made.

The oldest, and indeed the only Chinese word for Iron is

鐵 = *tie*: old sound *tit*.

It is mentioned in the list of articles of tribute—in the Yu Kung section of the Shoo King,* Book I., the tribute of Yu.

The following is the passage in which it occurs.

"The articles of tribute were musical gem stones, *Iron*, silver, *Steel*, stones for arrowheads, and sounding stones, with the skins of bears, great bears, foxes, and jackals, and articles woven with their hair."

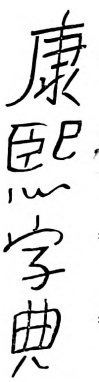
In a note Mr. Legge adds, "by 鐵 = *tie*, we are to understand 'soft Iron,' and by 鏤 *low or lowe*, 'hard Iron' or 'Steel.' The latter article is often used for 'to cut' and 'engrave,' with reference to the hardness of the tools necessary for such a purpose. In the time of the Han dynasty, 'Iron masters' (鐵官) were appointed in several districts of the old Leang-chou, to superintend the Ironworks. Ts'ae refers to two individuals mentioned in the 'Historical Records,' one of the surname Ch'o (卓氏), and the other of the surname Ch'ing (程) both of this part of the Empire, who became so wealthy by their smelting that they were deemed equal to princes. 銀 is the white metal or silver."

* See Legge's *Chinese Classics*, vol. iii., pt. i., p. 121. Trubner, London 1865.

I am informed by the Rev. Dr. Edkins of Pekin, that with the exception of this passage there is probably no distinct allusion to Iron in writings older than 1000 B.C. The Book of the Shoo King is estimated as having been compiled about 2000 B.C., or at a time when in Egypt hieroglyphic tablet-writing flourished, and centuries before a Greek nation had begun to sensibly exist.

The place where the Chinese worked Iron in these most ancient times was at Shansi and Chilili, in the Ho district, where there are inexhaustible deposits of both Iron ore and coal, where too they have continued to work Iron to the present day; indeed at the present moment * a Commissioner of Li-hung-chang, the Governor-General of Chilili, and now the first minister of the newly appointed young King of China, is at present in this country commissioned to take out new appliances and apparatus for establishing in China Ironworks on the modern systems of operation. Tsze-chou is the town in or near which these works are to be established, and it is 200 miles south-west of Tien-tsin, where the Governor-General resides.

How many ages have rolled by since the Chinese were separated from those other families of the human race who spread westwards, and therefore away from them in their emigrations from the highlands of Asia, it may be impossible to determine; but now that we are able to decipher the Chinese literary records, the fact is proven, that about 400 B.C. their celebrated author and philosopher Leih-Tze, was acquainted with the native process for making Steel, and indeed with the property of tempering it. In the



* *Vide* Appendix, p. 29 *et seq.*, kindly supplied by the Commissioner, Mr. James Henderson.

or *Kanghi's Dictionary*, published about A.D. 1710, the author, quoting from the writings of Leih-Tze, reports him as saying in regard to Steel, that "a red blade" (by which I take it is meant a *reddish coloured* blade, red being one of the great variety of tints which a clean surface of Steel acquires in the process of being tempered) "will cut jade as it would cut mud." That it is the colour of tempering and not the redness of highly heated Steel to which Leih-Tze alludes, is evident from the manner in which he mentions it in that connexion as capable of cutting jade, a stone of great hardness, upon which it is almost unnecessary to add that red hot Steel could make no impression.

Reflecting, then, for a moment upon the long continued isolation and stand-still character of the Chinese race, by virtue of which they have not up to this time, like other nations, undergone phases of either retrogression or progression, but have remained unmoved with an almost if not a quite constant stock of knowledge, tradition, and superstition from the earliest times of their settlement, it is natural to conclude that if we should find in comparatively later times a record of a process for making Steel there practised, to thereupon infer that the Steel referred to in the book of the Shoo King and in the writings of Leih-Tze, was produced by the same or by a very similar process. Accordingly, in the "Pi-tan" or "Pencil Talk" it is said that Steel is made in the following manner: "Wrought Iron is bent or twisted up, unwrought Iron (*i.e.*, which may mean either Cast Iron or Iron ore) is thrown into it. It is covered up with mud and subjected to the action of fire, and afterwards to the hammer."

Making due allowance for the quaintness of the expressions used, and perhaps the difficulty which a mind untrained in the technicalities of Iron and Steel manufacture, must of necessity encounter in conveying to us fully the exact idea of what the account was meant by its writer to express, it is surprising how remarkably near to a well-known process for making Steel the above translation approaches, namely, that of immersing Wrought Iron either into molten Cast Iron, or heating it with Iron ore and fuel, covered over with layers of mud or clay, to exclude as much as possible the oxidising influence of the external atmosphere, thereby deoxidising the Iron ore by contact with excess of carbon, and producing a molten carburet, in which the Wrought Iron eventually becomes immersed as in a bath.

I have previously pointed out* that Aristotle describes the Greeks to have practised this identical process about 400 B.C. We have

* Vide *Proceedings*, vol. viii., p. 244.

then the fact of two celebrated authors and philosophers, one in China, the other in Greece, who flourished simultaneously but utterly unknown to each other, describing a similar method of making Steel practised at the same time in each country,—these countries separated by vast mountain ranges and impassable deserts, into the far East and West from the cradle centre of the human race, which fact, indeed, seems to me as one of great weight in the chain of evidence now being collected, to prove from authentic data the original unity of mankind. I have previously pointed out that the Greeks obtained their metallurgical knowledge, like almost every other knowledge they had, from the Egyptians; but it is not easy to mark out the channel by which this old Steel process was conveyed to the Allophyllian races of China from either the Semitic or Aryan nations located near the shores of the Mediterranean; indeed, the only way of accounting for the fact is by returning once again to the old doctrine of the original unity of the human race, and allowing to each section of mankind the carrying off with them that common stock of knowledge which the entire family possessed before separation, and of which there is abundant evidence on every side that working in the metals, and Iron in particular, formed a very important element.

The Chinese account of Steel-making at this remote epoch is, however, extraordinarily complete in that it describes and names the different kinds of Steel which are produced. The Steel produced by the first treatment, the Iron-workers call Ball-Steel—*twăn Kang* (from its rounded form), or Sprinkled Steel, *Kwan Kang* (from the pouring of water). There is what is called "False Steel," *weĭ teĕ*, and the account goes on to say, "When I was sent on official business to Tse Chow, and visited the foundries there, I understood this for the first time. Iron has Steel within it, as meal contains vermicelli. Let it be subjected to fire, 100 times or more, it becomes lighter each time. If the firing be continued until the weight does not diminish it is Pure Steel."

In the Pent Śaow * it is said "there are three kinds of Steel,—

"1*st*. That which is produced by the adding of unwrought to Wrought Iron, while the mass is subject to the action of fire.

"2*nd*. Pure Iron many times subjected to fire produces Steel.

"3*rd*. Native Steel produced in the south-west at Hai-shan, and which is like in appearance to the stone called *Tsze-shih-ying*, purple stone efflorescence.

* A work of the Ming Dynasty, and Dr. Edkins informs me that the Pi-tan, already quoted, is probably also of that period.

"Steel is used for manufacturing swords and knives."

It is well known that Steel is still manufactured in China, and I have endeavoured to ascertain the process now used. This is, however, kept secret, and Mr. Henderson, to whom I have previously referred as Li-hung-Chang's Commissioner, at present in this country, explains to me "that the Steel which comes to Tien-tsin from the upper Yangstee is highly prized, and bears much higher prices than the Swedish Steel imported into China."

That the manufacture of Iron in early times must have reached considerable proportions is clear from another Chinese work coeval with the beginning of the Christian era, the name of which Dr. Edkins has promised to furnish me. It states that at that time a tax was levied upon Iron to contribute to the State Exchequer. Now it is clear that unless the manufacture had been a somewhat extensive one, it would not have been worth while to levy a tax upon it, for otherwise it could not have produced a revenue.

INDIA.

With regard to Indian iron manufacture I have, in the first place, to correct an error I formerly made * as to the date and place of the Iron Lâht at Delhi. From all that I could then gather it seemed to belong to a period ranging from the first to the fourth century of the present era; but since that time Lieutenant Cole's magnificent work † on ancient Delhi, of the existence of which I was not then aware, indeed it does not appear to have been published at the time my paper, which especially referred to the Lâht, was written —has come under my notice.

The Iron column instead of being situated where I formerly stated, is, I now find, in the axis of the colonnade of the Masjid-i-Kutb-ul-Islam.

M. Garcin de Tassy ‡ has translated the Persian account of the column written by Syud Ahmed, and has supplemented it with some weighty remarks, from which it appears to have been set up by an otherwise unknown king, Rajah Dhava, *alias Midhava*, and whilst it now seems that the forging was made in the 9th century B.C., or from 1100 to 1200 years earlier than I had formerly stated, yet the inscrip-

* Vide *Proceedings*, Vol. viii., p. 251, *et seq.*

† *The Architecture of Ancient Delhi, especially the Buildings around the Kutb Minar.* By Henry Hardy Cole, Lieutenant R.E., late Superintendent of the Archæological Survey of the North-Western Provinces of India. London: Published by the Arundel Society, 1872.

‡ *Les Monuments d'Architecture de Delhi.—Journal Asiatiques*, July, 1860.

tion upon it is of much later date, M. de Tassy concluding the inscription to be possibly as late as the third or fourth century of the present era, and inscribed therefore by a king long subsequent to its originator, who, indeed, we learn from Indian history, died in the course of its construction. I have also to add that a cast of this remarkable column is now on view at the South Kensington Museum; also, that a piece of the metal has been cut from the pillar, and this piece has been both forged and analysed by Dr. Percy, who has pronounced it as soft *Wrought Iron.*

Whilst speaking of India, I cannot, however, pass over that unique collection of archaic Iron and Steel tools which Colonel Pearse, R.A., found in excavating some tumuli at Wurree Gaon, near Kamptee, in India, which tumuli are believed to date from about 1500 B.C., or the time of Moses; and whilst we have no such solid relics of the tools used by the Hebrew race, yet we know from words in the Hebrew language that they were well acquainted with Iron in all its forms (see the appended Table), and this discovery (which, if the date assigned by Colonel Pearse be correct) shews at least that the contemporary nations were well acquainted with Iron and Steel; that their language, too, the Sanskrit, in its oldest forms has corresponding words for Iron, Iron ores, &c.

Colonel Pearse has presented his "find" to the Trustees of the British Museum, and I lately was fortunate in receiving from Colonel Pearse himself a full explanation of the several implements, which include gouges, spatulæ, ladles, and a variety of other articles.

The appended Table shews, from the evidence of language, that Iron was known amongst the most ancient nations in the very earliest times up to which it is possible to trace their existence.

CONCLUSION.

Having thus, I fear, seemed to have traversed over too wide an area for a single paper to discuss, yet hoping not to have wearied you with the details into which I have found it necessary to the due exposition of facts to enter, it will, I think, be conceded that in my very humble efforts to peel off some of the scales, the rust with which unyielding testimony from the oldest times has been corroded, I have at least laid bare a concatenation of facts out of which there is no escape from the conclusion that in all the earliest peopled countries, whether peopled by Semitic, Hamitic, Aryan, or Allophyllian races, there is most certain proof that in the remotest ages which we can ascertain anything about, the inhabitants were

familiar with the use and practical manufacture of Iron and Steel; that in those countries there is not a tissue of evidence in favour of a Bone or Stone age, still less of a Bronze and then an Iron age succeeding; that from the evidence adduced, and which indeed is being continually supplemented, it is evident the Stone, Bronze, and Iron theory must be consigned to the limbo of false ideas and exploded notions!

I cannot, however, close without expressing my indebtedness for invaluable aid in the preparation of this communication to Professor George Rawlinson of Oxford, and his brother, Sir Henry Rawlinson; to Dr. Birch, and Mr. George Smith, of the British Museum; to the Rev. Dr. Edkins, of Pekin; and last, though not least, to that prince of Egyptologists, Dr. Lepsius, of Berlin, who indeed has placed his valuable researches in my hands, and to which I may hope to draw attention on some future occasion.

APPENDIX.

CHINESE IRON MANUFACTURE.

THE day following the reading of the foregoing paper, Mr. Day was furnished by Mr. Henderson, the Commissioner from Li-hung-Chang to this country, with the subjoined "Notes from his Diary" during a ramble through Shansi in March 1874, which, containing useful information on the subject of the foregoing paper, the Physical Section have recommended to be published as an Appendix to Mr. Day's paper.

STEEL.

Mr. Henderson says: "In formerly writing you, I mentioned that Steel is made at or about Hankow, on the Yangstee, which still is considered very valuable by the Chinese, and brings a much higher price amongst them than the best English or Swedish Steel imported. How this Hankow Steel is made, I cannot say. I saw no Steel made, but some of the Iron is very fine; and when reheated by wood may, no doubt, have some of the properties of Steel."

IRON.

Regarding the native methods of making iron, Mr. Henderson has succeeded in obtaining much more complete information, as

contained in the following, which, to make intelligible to Europeans, he has prefaced with a table of arithmetical values.

CHINESE COINS AND WEIGHTS VALUE.

One tael of silver is valued at		6s. 0d.
Number of cash in a tael, is	1680, . . .	6s. 0d.
cash	280, . . .	1s. 0d.
cash	140, . . .	0s. 6d.
cash	$23\frac{1}{2}$, . . .	0s. 1d.

In the calculation of silver money,

10 cash makes one condarin.
10 condarins one muci.
10 muci one tael.

In the weight of coals or other bulky goods—

100 catties is equal to 1 pecul,
1 pecul ,, $133\frac{1}{3}$ lbs. avoirdupois.
16 peculs 80 catties is equal to 2240 lbs. or 1 ton.

IRONWORKS 10 TO 13 MILES FROM YANG-CHING SHANSI, CHINA.

On the northern side of the valley stand the smelting establishments. There seemed to be eight or ten of them, with immense heaps of broken moulds before them.

Behind the Ironworks are the low hills, containing both the coal and the Iron ore. Visited one of the smelting establishments; they have been well described by Baron Richtopen and Dr. Williamson. Saw the anthracite coal and the Iron ore. Coals cost at the hills behind the works 20 to 25 cash (1d.) per basket of 80 catties (107 lbs.), and never exceed 30 cash. Iron ore, inferior, cost 20 cash (1d.) per pecul, and for the very best about 50 cash (2d.) per pecul (133 lbs.) at the mountain. By a pecul our informant meant as much as a man could carry. In smelting, 100 peculs of Iron ore, if very pure, yields 90 catties of Iron; if slightly inferior, 85 catties, and if common, 80 catties. On a second smelting the Iron loses 10 per cent., some say 5 per cent., and is then made into pots and pans of Cast Iron, but as the goods contain some of the sand, the loss in Iron is only about 5 per cent. The third time the Iron is smelted it is made into bars. By this time the original 90 catties has come to be only 70 catties, or even less, if not very good. To be made into other articles it may be smelted four, five, or six times, and in the latter case it is fit for needles.

We saw the open furnaces, in which were 66 crucibles, and which take a day and a half to smelt. The smeltings turn out very unequally; the 66 crucibles may turn out 8 peculs in all, if very good ore, and if poor ore only 5 peculs. The produce of the first smelting sells at 5 cash per catty, and the Bar Iron of the third smelting at 16 cash, at this place.

Following the bank of the Ching-ho we came by the river side to some smelting establishments. At this place they did not smelt from the ore, but purchased the Iron after it was smelted at 5 cash per catty, and from this they made their pots and pans. Here they told us that on smelting a second time for castings, the out-turn was only about 70 per cent. of the first smeltings.

At Zuang-yin-san the owner of the mountain carries his Iron to a distance of 30 li (10 miles), and sells it to the manufacturers at 200 cash for 300 catties, allowing $3\frac{1}{3}$ cash per pecul per li for carriage. This would give the value of the ore of the mines as being $33\frac{1}{2}$ cash per pecul ($1\frac{1}{2}$d. for 133 lbs.). Kung-san Iron is not so good, 4 taels weight (or 25 per cent.) cannot be got out of a catty.

At these places the Iron is very soft, and in appearance like coarse-grained red sandstone.

At Su-chuan there is a large smelting establishment, the smelting being done in large pits, each holding about 25 peculs of ore. The smelting occupies one day, and after smelting it is allowed to remain in the pit one day to cool; it comes out in one piece, weighing apparently about 6 peculs, and is sold in this state at 5 cash per catty.

They could not tell us how much coal was used to smelt one of these masses of Iron.

The workmen are paid 60 cash per day and food, food consisting generally of small millet and a little salt, no vegetables, and may cost about 20 cash.

This Iron is of the same description as we saw at the Chung-ho establishment, which loses 30 per cent. on being smelted a second time.

Visited another large establishment, where they made principally *Bar Iron;* at the first smelting the ores give 25 to 30 per cent of Iron. This was smelted a second and a third time for bars, when it again lost 20 per cent., the proceeds of the first Iron giving only 80 per cent. This Bar Iron is said to sell at 20 cash per catty. We

saw at this establishment many of the little cops of Iron which came out of the crucibles, and they differed greatly in thickness and in weight, being from 5 to 8 catties.

Here we also saw an immense oblong stack of firewood, some 60 × 20 × 20 feet, for use in smelting where Bar Iron is to be made.

At Ping-ding chow, or 7 miles north of it, we entered the first smelting establishment we came to.

They had here in the open furnace 128 crucibles, these crucibles being about 4 feet high, and 6 to 7 inches in diameter. Out of these 128 crucibles they would get about 15 peculs of Iron, equal to about 40 per cent., to smelt which will take about 10 mule loads of coal—*i.e.*, about 20 peculs or 1½ tons; the produce of the first smelting sells at 5 cash per catty.

At the second establishment we were told that out of the coarse yellow Iron ore they could get 40 per cent., and out of the best dark ore they could get 60 per cent. They were mixing here the two kinds of ore. It was all pounded small before being put into crucibles. In the second smelting, if Wrought Iron is to be made of it, wood alone is used, thus making it fine and tough; for the third or fourth smelting coal is again used.

At a third smelting establishment they were making moulds for pans. The first smelting here will produce about 60 per cent. from the ore, but this contains a great deal of impurity; and upon this being smelted a second time, it will again turn out only about 60 per cent. of the first smelting. The contents of 128 crucibles of the first smelting are put into 63 crucibles, and these turn out on a second smelting enough Iron to make about 50 pans.

Time required for the first smelting, 2 days; for the second smelting, 1 day.

The Chinese idea of percentage of Iron from the ore is evidently a purely imaginary one, for they never weigh the ore. With coal and Iron ore both so plentiful and cheap, the Iron is so much per donkey load, as much as the animal can carry.

Some Iron ore we purchased at Ping-ding Chow, shewed, at the Royal School of Mines, London, to contain 50 per cent. of Iron. It is loose hematite, and contains little or no sulphur.

INDIA.

Mr. Henderson at the same time has forwarded the following letter from Mr. Bourne, and has Mr. Bourne's sanction to publish the same :—

66 Mark Lane,
London, E.C., 26*th April*, 1875.

James Henderson, Esq.

My Dear Sir,

I have seen the native process of making Iron in many parts of India, and it is substantially the same in all. A furnace—of say 20 inches internal diameter—is built of clay, breast high, and has the pipes of some sort of bellows entering at the bottom; while the charcoal and the ore, broken into small pieces, are put in at the top. After blowing for some time a hole is opened, about half way up, in the front of the furnace, out of which a large mass of Spongy Iron is taken, and this mass is re-heated and hammered into small ingots sharpened at each end, in which state it is sold. The late Mr. Heath informed me that he has seen furnaces in India about three times the height of the foregoing, which furnaces produced Cast Iron, the sole use of which was to melt with Wrought Iron for the production of Steel, as is now done in the Bessemer process. But these furnaces I never myself came across, and they are not common. The wootz is produced by melting Wrought Iron in small crucibles, into which some twigs and a green leaf from a certain tree are introduced, and the crucibles are then stopped with clay formed into a pyramid, over which a dome is built, and heat is applied, when the Wrought Iron melts and combining with the charcoal of the green twigs forms Steel. Charcoal will not do as a substitute for the green twigs. The Steel takes the shape of half the crucible, and is of the shape and size of half an egg. In making the Damascus blades each piece of wootz was drawn out into a riband of the proper length, and a bundle of these ribands was then welded together. This process produces the exact markings to be found on the old Damascus blades.

Regarding the testimony touching the antiquity of Iron, I may mention that shortly after my first visit to India I came across a book of Egyptian hieroglyphics and drawings, where one of the objects represented was the manufacture of Iron after precisely the same fashion as I had seen it practised in India. If I had not been in India I should not have known what was intended to be represented; but having seen the mode of procedure in India I recognised it at once. I do not now remember what the book was in which I saw

this, or what epoch it was supposed to represent. But this, no doubt, could be discovered by any one who knew the Indian mode of manufacture, and who was interested in the subject.

I remain,

Yours very truly,

JOHN BOURNE.

ANALYSIS OF IRON FROM THE GREAT PYRAMID.

The following letter to Dr. Birch, Keeper of the Oriental Antiquities at the British Museum, describing the chemical constitution of the piece of Iron found by Colonel Howard Vyse in the Great Pyramid, having been received since the foregoing paper was read, is here inscribed as descriptive of the character of the oldest piece of Iron known.

MINERAL DEPARTMENT, BRITISH MUSEUM,
12*th May*, 1875.

DEAR DR. BIRCH,

The result of my examination of the fragment of Iron (?No. 3453) from the air-passage of the Great Pyramid, goes to shew that *it is not of meteoric origin.* It contains, it is true, a trace of Nickel, but it is only a trace. It is, in fact, by no means an uncommon occurrence for a trace of that metal to be met with in manufactured Iron, derived from its various ores; and several analysts have detected the presence of Nickel oxide in the ores likewise. According to Pattison (*Brit. Assoc. Rep.*, 1864, p. 49) the Cleveland Ironstone contains in 1 lb. of ore 0·72 grain of Nickel and 0·12 grain of Cobalt. O. L. Erdmann (*Jour. Prakt. Chem.*, xcvii. 120) states that he has many times found traces of Cobalt (the *alter ipse* of Nickel and constant associate of Nickel in meteoric Iron) in Iron ores, and still more frequently in samples of commercial Iron. It should be stated, by the way, that the presence of a trace of Cobalt is more readily recognised than the same amount of Nickel would be. C. O. Brann (*Zeit. Annl. Chem.*, v. 226) mentions the fact that in many analyses of Iron which have been carried out in the Wiesbaden laboratory, the presence of Nickel

and Cobalt has been recognised. G. Lippert (*Zeit. Annl. Chem.*, ii. 41) found in the Spiegeleisen, obtained from the Spathic Iron ore of Stahlberg, near Musen, 0·016 per cent. of Nickel and a trace of Cobalt.

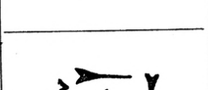
The fragment of Egyptian Iron contains combined carbon, an occurrence of great rarity in meteoric Iron. The locksmith who removed it from the specimen tells me that under the saw it behaves like Wrought Iron, and I find its magnetic character to accord with Wrought Iron rather than with Steel.

Believe me, Dear Dr. Birch,

Yours very truly,

(Signed) WALTER FLIGHT.

BELL AND BAIN, PRINTERS, GLASGOW.

Language.		Characters.	Phonetic Value.	English Equivalent.	Oldest known Date of.
Name.	Family.				
Egyptian Hieroglyphs.	Hamitic, with Semitic Infusion.		Ba. Ba. Baa. Baaenpe. Bet.	Earth, Metal. Iron. Iron, Earth. Iron. Iron.	2,200 to 2,300 B.C.
Akkadian.	Semitic.		Hurud.	Iron.	Oldest Monuments, at least 2,000 B.C.
Assyrian.			Eru.	Iron.	
Hebrew.		נְחוֹשֶׁת בַּרְזֶל בַּרְזֶל עֶשׁוּחַ בַּרְזֶל מוּצָק	n''ghoo-shāh' Barzel. Barzel "gāh-shooth Barzel moo-tzāhk'	Steel. Iron. Bright Iron. Cast Iron.	From 1,500 B.C. downwards.
Chinese.	Sporadic, or Allophyllian.	鏤 鐵 金 鐵官	Low. T'ieh. Kin. ...	Steel. Iron. Metal. Ironmasters.	2,000 B.C.
Sanskrit.	Aryan.	आर् अयस्	Ara. Ayas.	Iron. Iron.	Oldest Sanskrit. Probably B.C. 1,500
Greek.		χάλυψ σίδηρος κύανος ἀδάμασ	Kalups. Sideros. Kuanos. Adamas.	Steel. Iron. Blue coloured Metal, probably Tempered Steel. Steel.	Homeric Age. ——— Hesiod.