In their historical works Fergusson, Râjendralâl, Havell, Vincent Smith, and Manomohan Ganguly have sufficiently noted the manipulation of metals and gems in Hindu art. The tenth chapter of Vincent Smith's work, that on Hindu minor arts, deals, among other things, with the following topics relevant to the points discussed here : (1) coinage, (2) gems, seals and jade, (3) jewellery, (4) reliquaries and gold images, (5) silver pateræ and bowls, (6) copper-vessels.

The use of metals for the fabrication of domestic vessels in Hindu India is thus described by Dr. Râjendralâl in the paper on *Furniture, Domestic Utensils* etc., in *Indo-Aryans*, Vol. I:—"The Rig-Veda alludes to golden cups ; The Sutras and the Mahâbhârata frequently refer to vessels of other than gold and clay. Tvâshta, the Vulcan of the Hindu pantheon, was the most celebrated artificer of metallic arms, but the Ribhus greatly excelled him in the formation of sacrificial vessels of wood and metal.

In a mediaeval work, the *Kâlikâ Purâṇa*, plates made of gold, are described to remove excesses of the three humours, and promote the strength of vision ; those of silver favourable to vision and inimical to bile, but calculated to increase the secretion of wind and phlegm ; those of bronze, agreeable and intellectual, but favourable to undue excitement of blood and bile; those of brass, wind-generating, irritating, hot, and heat-and-phlegm-destroying ; those of magnetic iron, most beneficial in overcoming anasarea, jaundice and anæmia. The *Yuktikalpataru* recommends that drinking cups for royal personages should be made of gold, silver, crystal or glass."

The *Periplus* describes Muziris, a port on the Arabian coast, whence Romans used to carry pearl, ivory, diamonds, rubies, topazes, stibium, coral, flint, glass, brass, arsenic and lead. Mr. Aiyangar in his *Ancient India* quotes the Tamil classic *Ahanâ-nûru* to prove the flourishing condition of "Musiri to which come the well-rigged ships of the Yavanas."

Section 7.

The Doctrine of Seven Metals.[1]

Sukraniti mentions seven metals *viz.*, suvarṇa (gold), rajata (silver), tâmra (copper), vanga (tin), sisa (lead), rangaka (zinc) and loha (iron) under the name of *dhâtus* ; and two alloys under the name of *sankaras, viz.*, kâmsya *i.e.*, bronze or bell-metal (which is made of vanga and tâmra) and pittala or brass (which is made of tâmra and ranga).

The names, number, and classes of metals as given in *Sukraniti* are not, however, the same as in other works on the subject in Sanskrit literature. The

[1] Sukra IV, ii, 171-176. The reader is requested to note the following changes in my translation of Sukranîti : He may read bell-metal for bronze on page 144, and should understand zinc wherever there is tin and tin wherever there is zinc. The word *vanga* is generally a term for tin. But in *Dhâtukriya* of the 16th century *ranga* is also used to denote tin. See śloka 12 in Dr. Ray's edition of Sanskrit Text. That is perhaps the only use. So I take *ranga* as the term for zinc (and not tin, as in the Translation). See Prof. Yogesa Chandra's *Ratnaparikṣâ*.

chemico-medical treatises that treat specially of the minerals are very diverse in the matter of enumeration, classification and synonyms. Each represents in fact to a certain extent the cultural characteristics of the place or epoch in which it was composed.

The word *rangaka*[1] which has been taken here as a synonym for zinc has been used only thrice.[2] Another word has also been used as a synonym for *rangaka or* zinc. This is *jasadâ*.[3] But the terms rangaka and jasada are not to be met with in older literature, nor is even the substance which is denoted by these terms mentioned there as one of the metals.

Vedic Period.

In Vedic literature we meet with six or perhaps seven metals : (1) Gold[4] called by the names of Candra, Jâtarûpa, Suvarṇa, Hârita, and Hiraṇya, (2) Silver called Rajata,[5] (3) Copper called Loha,[6] (4) Tin called trapu[7] (5) Iron[8] called Ayas, kriṣṇayasa, syâma, (6) Lead called Sîsâ[9] Perhaps bronze is also suggested.

According to Messrs. Macdonell and Keith, the exact metal denoted by the word *ayas* when used by itself, as always in the Rigveda, is uncertain As favouring the sense of bronze rather than that of iron may be cited the fact that Agni is called *ayo-damstra*, (with the teeth of *ayas*) with reference to the colour of his flames, and that the car-seat of Mitra and Varuna is called ayasthuna (with pillars of ayas) at the setting of the sun. Moreover, in the Vâjasaneyi Samhitâ ayas is enumerated in a list of six metals : gold (hiraṇya), ayas, syâma, lohâ, lead (sisa), tin (trapu). Here syâma (swarthy) and loha (red) must mean iron and copper, respectively ; ayas would therefore seem to mean bronze. In many passages in the Atharvaveda and other books the ayas is divided into two species—the syâma (iron) and lohita (copper or bronze). In the Satapatha-Brâhmaṇa a distinction is drawn between ayas and lohayasa which may either be a distinction between iron and copper or between copper and bronze In one passage of the Atharvaveda[10] the sense of iron seems certain. Possibly, too, the arrow of the Rigveda which had a tip of ayas was pointed with iron. Copper, however, is conceivable, and bronze quite likely. The Satapatha-Brâhmaṇa states that if " well-melted " it is like gold, referring evidently to bronze.

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[1] For the antiquity of the word and its history see *Susruta*, *Madanapâla* and *Dhâtukriyâ* referred to subsequently.

[2] Sukra IV, ii, 173-175, 176, 183, 144.

[3] Sukra IV, v, 646-648, 658-659.

[4] Max Müller and Keith's *Vedic Index* Vol. I, 254, 281, 31 ; II, 459, 498, 504, 505.

[5] *Vedic Index* Vol. II, 197.

[6] *Vedic Index* Vol. I, 31 ; II, 234.

[7] *Vedic Index* I, 31, 326.

[8] *Vedic Index* I, 31, 32, 151.

[9] *Vedic Index* I, 31, 452.

[10] V. 28, 1, see Vol. I, p. 272 Harvard Oriental Series.

The following is taken from Dr. Ray's *History of Hindu Chemistry* :[1] In Vedic literature iron proper seems to be designated *kriṣṇâyas* or the black metal,[2] and copper by *lohitâyasa* or the red metal.

Besides gold and silver, several other metals, *e.g.*, iron, lead and tin are mentioned in the white Yajurveda XVIII, 13. In the Chhândogya Upaniṣad IV, 17, 7, we also read "As one binds gold by means of lavana (borax), and silver by means of gold, and tin by means of silver, and lead by means of tin, and iron by means of lead, and wood by means of iron, and also by means of leather."

At least three metals are mentioned in Atharvaveda,[3] used for amulets to be put on against demons, for long life or for safety. These are gold, lead and iron.

Vedic literature thus testifies to the antiquity of Hindu metallurgy and to the varieties of nomenclature used in designating the metals.

Charaka-Susruta.

The Charaka mentions suvarṇa and five *lohâs* or metals, but does not name any.[4] Kavirâja Avinâs Chandra Kaviratna calls them silver, copper, lead, tin and iron. It is to be noted that the word *dhâtu* does not occur here, and that *lohâ*[5] is a generic name for metals, almost like *ayas* in Vedic literature.

The Susruta[6] mentions six metals under the heading of *trapu* (tin) *order* among the 37 classes of drugs enumerated in Chapter XXXVIII of Sutra-sthâna. These are trapu (tin), sisâ (lead) tâmra (copper), rajata (silver), kriṣṇa-loha (iron), and suvarṇa. But in Chapter LXIV, while treating of the *Lavanas*, Susruta mentions 7 metals[7] and describes their properties. The additional one is kâmsya or bell-metal. A new name is also introduced. This is *ranga*, perhaps a synonym or misprint for *vanga*, which is trapu or tin. But if *ranga* be the correct reading, we have here the authority for the use of the term in the same sense of tin in *Madanapâla-nighantu* and *Dhâtukriyâ*, works of the fourteenth and sixteenth century respectively.

The doctrine of six metals continued.

At least five metals are referred to in Mahâbhârata,[8] *viz.*, gold, silver, copper, iron and *Kâmsya*. *Amarakoṣa*, a work not later than the 6th century

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[1] Vol. I, first edition, p. 88.

[2] Book I, 16, 35 ; Book V, 28.

[3] The Susruta also differentiates iron by the term *Kriṣṇaloha* (black metal), though copper is known by its proper name *tâmra*.

[4] See the Sanskrit text edited by the Kavirajas Devendranath Sen and Upendranath Sen (1897), p. 7.

[5] In the section on the *Doctrine of Nine Gems*, the two pairs of convertible terms (1) Dhâtu and loha, and (2) Ratna and maṇi have been treated historically.

[6] See p. 181 of the Bengali translation of *Susruta Samhitâ* by Kavirajas Devendranath Sen and Upendranath Sen (1900).

[7] See the Bengali translation, p. 968.

[8] Prof. Yoges Chandra Ray's *Ratnapariksâ* (1904), p. 154.

A.D., mentions gold, silver, copper, kâmsya, pittala (brass), iron, tin, mercury and *sauviranjana* (*stibnite*). Pittala or brass is thus at least as old as the sixth century. It is also mentioned by Varâhamihira of the same age. The use of mercury as a drug is also at least as old as Varâhamihira.

The *Rasârnava*[1] of Nâgârjuna (8th cent.) mentions six *lohas* or metals: suvarṇa, rajata, tâmra, *tikṣṇa* (iron), vanga (tin) and *bhujangama* (lead). Here we get tîkṣṇa and bhujangama, two new names for substances used since Vedic times.

The *Rasaratnâkara* of the same author gives new names to the metals. Thus silver is *sitâ* and *târa*, copper is *sulva*, lead is *nâga*.

The *Rasahridaya*,[2] a work of the eleventh century, uses *nâga* for lead, *tikṣṇa* for iron, and gives three classes of metals: (1) noble, *e.g.*, gold, and silver, (2) essential or substantial, *e.g.*, copper, brass (âra), *tikṣṇa* and kânta (varieties of iron), and (3) those which emit fœtid odours, *e.g.*, lead and tin.

The *Rasaprakâsasudhâkara* of the thirteenth century gives the name *târa* for silver. The *Rasakalpa* of the same age mentions six *lohas* or metals, *e.g.*, hema (gold), rupya (silver), arka (copper), vanga (tin), *ahi*[3] (lead) and lauha (iron). Varta and others are also mentioned as alloys.

The 14th century.

The *Rasaratna-samuchchaya* of the fourteenth century, which quotes passages *verbatim* from Rasârṇava and other authorities, begins its Fifth Book that on *lohas* or metals with the following words: 'The *śuddha* or pure metals are kanaka (gold), rajata (silver) and loha (iron). The *Puti lohas* (those emitting fœtid odour) are two, *viz.*: nâga (lead) and vanga (tin). The *misra* or alloys are three in number, *viz.* pittala (brass), kâmsya (bell-metal), and varta. The *Loha* metal is loha or iron, and often conveys different meanings.' Here we have five metals divided into two classes, and the 3 alloys regarded as forming a class by themselves. This enumeration, nomenclature and classification of metals may be compared with those in *Sukraniti*, thus :—

(1) *Loha* is the generic name for metal in R. R. S. whereas *dhâtu* is the word for it in Sukra.

(2) Sukra includes *rangaka*, a new metal among the pure metals and thus gives the number seven, whereas according to R. R. S. the number is only five, but six later.

(3) The alloys are two in *Sukraniti*, but three in R. R. S., including *vartaloha* 'which is produced from kâmsya, copper, pittala, iron and lead and is thus an alloy of five matals.'

The *Rasaratna-samuchchaya* often uses *ayas* for iron, and mentions *tikṣṇa* and *kânta* as two of its three species. In Book X, 70, it refers to the six

[1] See Sanskrit Text edited by Dr. Ray, Vol. II, 89, 90.

[2] See Sanskrit Text edited by Dr. Ray, also *Hindu Chemistry*, Vol. II, p. 11.

[3] See Dr. Ray's edition of the Sanskrit texts in *Hindu Chemistry*, Vol. II.

metals, but mentions only two alloys like *Sukraniti*. *Trapu* is the word used here for vanga or tin.

The *Sârangadhara*[1] of the same age recognises seven metals, though it does not mention zinc, but later names nine metals including two alloys, brass and bell-metal, after the nine planets.

The fourth chapter named *Suvarṇavarga* of *Madanapâla-nighantu*, another work of the 14th century, however, mentions suvarṇa, rupya, tâmra, kâmsya, pittala, ranga or vanga, jasada (zinc), sîsa, lohâ (iron), sulphur, mercury, gems, etc. It gives the synonyms of these metals also, and treats of their properties. It is to be noted that ranga, vanga and trapu are used as synonyms to indicate tin; and jasada is described as being '*ranga-sadṛisa*' *i.e.*, like ranga or vanga.

Madanapâla and Sukra thus agree in almost all particulars. Both mention the same nine metals. Madanapâla does not classify them, and enumerates some more, *e.g.*, sulphur, mercury, abhra, etc., while *Sukraniti* regards the alloys, brass and bell-metal as forming a category distinct from the unalloyed seven. The only real difference is that Sukra takes *rangaka* as something different from *vanga* (which has been always known to be tin). From the composition that he gives of pittala (alloy of copper and *rangaka*) we find no difficulty in identifying his *ranga* with zinc. *Sukraniti* requires to be noted on another point also. This is about the use of the term *jasada*, which has been given in Madanapâla to designate zinc The *jasada* and *rangaka* of *Sukraniti* are thus synonyms denoting the same substance—zinc.

Though it is not rational to argue anything from mere non-mention we may tentatively conclude, subject to the fallacy of *argumentum ex silentio*, that the portions of *Sukraniti* dealing with metals must be attributed to people living about or after 1374, the year of the composition of Madanapâla-nighantu,[2] but not earlier.[3]

Subsequent notions.

The same seven metals including zinc are mentioned in Dhâturatnamâla, also, another work of the same epoch which gives *Kharpara* the name of *jasada*; and in the *Dhâtukriyâ* of the 16th century which gives the synonyms of all the metals. In this last work zinc is called jâsatwa, jasa-dâyaka, rupya-bhrâtâ (brother to silver), charmaka, kharpara, rasaka;[4] and the two alloys mentioned in *Sukraniti* are also enumerated. The tradition of the seven

[1] See *Hindu Chemistry*, Vol. II, LXX.

[2] See Text edited by Pandit Jivânanda Vidyâsagara (1875), pp. 50-52.

[3] It would be interesting to observe that in Europe also the Doctrine of seven metals held its sway for long. It was supposed that there was a mystic connexion between the planets and the metals. Thus gold, the prince of metals, was the favourite of Sun, the lord of the firmament, liquid mercury was the favourite of the planet Mercury, the changeful deity; and so on. This idea of the connexion between planets and things of this world will be treated of in the section on the *Doctrine of Nine Gems*.

[4] "Rasaka and Kharpara are the names generally applied to the mineral calamine" Dr Ray.

metals is continued in the Bhâvaprakâsa of the 16th century which describes tin by the name of *ranga* and zinc by jasada. But *Râjanighantu* of the 17th century does not mention zinc, though it enumerates the two alloys and seven metals. *Kṣudrasuvarṇa* is mentioned in the place of zinc.

Whether the authors have reckoned only six *lohas* or seven (as since 14th century downwards), the principle has been to count the pure or unalloyed metals only. Later, the doctrine of seven pure metals is replaced by that of eight and nine metals, without reference to their character as pure or alloys. Thus Dr. Râmadâsa Sen quotes a *Vaidyaka* text which regards gold, silver, copper, iron, *Kusya* (zinc), mercury, ranga (tin) and lead as the eight principal *dhâtus*. Another version of the tradition of eight metals is supplied by *Dânasagara* which gives gold, silver, *kâmsya* (the alloy bell-metal), copper, lead, ranga (tin), iron and raita (brass).

The *Sukhabodha* considers nine metals to be chief, *e.g.*, gold, silver, âra (brass), nâga (lead), copper, ranga (tin), tikṣṇa (species of iron, steel), kâmsya (bell-metal) and kânta lauha (species of iron). This list does not give zinc, mentions iron twice, and includes the two alloys which are known to the author as such, according to Dr. Sen.[1]

It is to be noted, moreover, that in the extracts from Bhâvaprakâsa and other works just quoted, the word *ranga* is used not for zinc (as, in *Sukranîti*, a synonym for jasada), but for vanga, trapu or tin (as in Susruta, Madanapâla, and Dhâtukriyâ).

Another fact should draw our attention. In the whole literature on the subject from the earliest times, mercury has not been mentioned in any list of metals, except in the above quotation from vaidyaka; though its use as a medicinal drug has been known since at least the epoch of *Sârangadhara-Sangraha* (14th century),[2] according to Dr. Dutt, but according to Dr. Ray, since at least the age of Varâhamihira[3] (6th century), who mentions 'iron and mercury among the aphrodisiacs and tonics' in *Brihat Samhitâ*.

Explanation of the number Seven.

The foregoing account will have shown that the '*Doctrine of Seven Metals*' represents only certain stages in the story of metals in Indian literature. Allowing for the fallacy of *argumentum ex silentio*, we have placed it in the epoch between the 14th and 17th century. For an explanation or 'philosophy' of this doctrine we may hazard a hypothesis. Perhaps it is to be sought

[1] See Ramadasa Sen's *Ratna-rahasya*, a Bengali work already referred to.

[2] 'The oldest work containing a detailed account of the calcination or preparation of the different metals (such as gold, silver, iron, mercury, copper, tin and lead) is, I believe, a concise treatise on medicinal preparations by Sârangadhara.'—Dr. Dutt's Preface to his *Materia Medica of the Hindus*. Dr. Dutt believes that mercury was just coming into use in Chakrapâni's time (11th century).

[3] *Hindu Chemistry*, Vol. I, xlvii. First Edition. 'The *Rasârṇava* of Nagarjuna (8th century) is, as the name implies, the 'sea of mercury' and extols the virtues of mercury and its various preparations.' The discovery of this work by Dr. Ray also falsifies the notion of Dr. Dutt and testifies to the antiquity of the internal use of mercury.

in the Theory of Mystic Numbers like three, seven, nine, etc., which has had its day in both eastern and western thought. So far as seven is concerned, in India we have the seven Rishis, the seven mouths or tongues of Fire, the seven *Kulaparvatas* or mountains, the seven rivers, the seven planets or *grahas*, the seven heavens, the seven seas (salt, curd, milk, etc.), the constellation of seven stars called saptarṣimandala, the seven immortals (*chirajivinah*) etc. The tradition of seven being the number of principal metals may have had its origin in the same tendency of people to tabulate important facts and things of the world according to one or other of the numeral orders. Or, originally, the doctrine may have had nothing to do with mystic numbers—it may have been the result of a simple observation of mineralogical facts.

The arguments of Dr. Ray to prove the indigenous origin of Indian alchemy incidentally throw important light on the doctrine of seven metals both in the east and the west, and demonstrate the absence of any mystic connexion between planets and metals in Hindu thought. 'One of the most favourite doctrines of the neo-Platonists was that the metals were engendered in the womb of the earth under the influence of the planets. According to Olympiodorus (5th century A.D.) lead is begotten by Saturn, electrum by Jupiter, iron by Mars, copper by Venus, tin by Hermes, gold by the Sun and silver by the Moon. *** Varâhamihira's *Brihat Samhitâ*, if anything, is a repertory of astrological notions. In vain do we look even there for any chance and solitary reference. The alchemical literature of India is equally silent about it. *** The old Greek writers repeatedly refer to the mystic relationship between the seven planets and the seven metals. *** The Arabs who adopted many of the Greek doctrines of alchemy also represented the seven metals by the seven planets. ** But in Sanskrit literature we find invariably six metals. It is only in the Sârangadhara and other later works that we find seven metals; ** but this author adds two more to the list and quietly lays down that there are nine metals, which derive their names from the nine planets.[1] ** Rajputana had been overrun and occupied for a brief period by the Musalman conquerors shortly before the time of Sârangadhara, and it is reasonable to suppose that he had gleaned some astrological notions from that quarter.'[2]

Finally, it may be observed that while in India the doctrine of nine gems was influenced by that of nine planets, the doctrine of seven metals was influenced, if at all, by that of *seven* planets.

Section 8.

The Economic Mineralogy of Sukrâchâryya's India.

(a) *The Pure Metals.*

References to gold as to other minerals in *Sukraniti* are commercial, financial and industrial. The statesmen of the Sukra cycle are concerned

[1] See the discussion in the section on the *Doctrine of Nine Gems.*

[2] Dr. Ray's *Hindu Chemistry* Vol. II, lxxxvi—xc.

with them principally as marketable commodities and possessing some 'value.' Identification of these metals, examination of their genuineness, and determination of their 'price' in terms of money are the chief topics dealt with by Sukrâchâryya. A study of these references will thus be a main source of our knowledge of the commercial geography and economic history of India in ancient times, and incidentally of mining,[1] minting, metallurgy and other industries.

It is not safe, however, to infer anything as to the *locale* of *Sukraniti* from the references to mines and metals, as (i) they are more or less of a vague character and (ii) the mineral products are very mobile and easily transportable, commanding what is known as the 'world-market.' Perhaps the definite references to the rates of royalty, remuneration and prices apply to the ideas generally prevalent rather than to those of any one mineralogical zone, *e.g.*, Râjputana, Deccan, &c.

i. *Gold.*[2]

The lustre and brilliancy of gold are well-known to the Sukra authors. Gold,[3] according to them, is the best metal. Its appreciation as an ornament used in decorating the person of human beings is referred to. The making of ornaments with gold is a *kalâ*.[4]

Testing.

There are two methods by which gold can be identified. The first method consists in differentiating it from other metals.[5] The test is given in the rule that "gold of the same weight as other metals is small in volume. Others are bulky." The density of gold being high, there will necessarily be great weight in small bulk. Thus, though the gold coin *mohur* and silver rupee have the same weight, the mohur is smaller in size than the rupee. The second method consists in differentiating pure gold from imitation gold or an alloy or some other metal. The test as described previously is conducted in the following way: "If two pieces of a metal,[6] one pure and the other suspected as alloy, be successively passed through the same hole, and threads of equal lengths be drawn out of them and weighed, and if the weights of both are equal, then the metal is unalloyed, otherwise not." Thus, as Prof. Yoges Chandra Ray says, if the weight of, say, copper wire be 8, that of gold wire of the same length (drawn through the same hole and hence having the same width) would be 19. Or take copper and gold of the same weight, and

[1] For an account of mines and minerals in Modern India, see the Indian Empire in the *Imperial Gazetteer of India* Series. Descriptive and Economic Volumes (I and III).

[2] Principal Burns in his monograph on *Gold and Silver work in the Bombay Presidency* (1904) has dealt with the subject a bit historically. Cf. also "Paris Universal Exhibition, 1878: Handbook to the Indian Court," by Sir George Birdwood, pp. 59-61, second edition.

[3] Sukra IV, ii, 173-175.

[4] Sukra IV, iii, 179.

[5] Sukra IV, ii, 177.

[6] Sukra IV, ii, 178-179.

draw two wires through the same hole; then if the length of gold wire be 8, that of the copper wire would be 19. Both these tests of Sukrâchâryya are thus dependent on the theory of Specific Gravity.

The use of gold in art for decorative or utilitarian purposes necessarily introduces difficulties in the matter of testing the genuineness or otherwise of the material worked upon. The following are the rules for the guidance of people: (1) when one hundred *palas* of gold[1] is taken and melted, it is pure if it still remains one hundred palas, and does not become less. (2) In articles of the best workmanship gold[2] is lost by a two-hundredth part of itself, (while silver by a hundredth part); and if soldered by using good material, the weight is increased by a sixteenth part. Having examined the soldering and the workmanship, the increase or decrease should be determined.

The Sukra statesmen are of course specially interested in the ability to distinguish the values of gems and metals and differentiate the genuine from counterfeit coins or imitation from pure metals. And the testing of the worth of gold was certainly a very common phenomenon in Sukra's times, as it still is. For the examination of the genuineness of precious metals supplied an analogy with the examination of the character of officers and servants. Thus we read: "Just as gold[3] is tested by experts by having reference to the lightness or heaviness of weight, colour, sound, etc., so also one should examine servants or officers by reference to their work, companionship, merits, habits, family relations, &c."

As Wealth and as Money.

Several references in *Sukraniti* point to gold and silver, specially the former being the 'measure' or 'standard' of value. Its functions as the 'medium of exchange' is also frequently indicated. Thus among the things to be studied by the king for four *muhurtas*[4] before meals we find gold[5] mentioned along with grains, clothes, jewels, &c. Gold is here to be taken either as a valuable commodity (Bullion) *i.e.*, a form of 'wealth' hoarded in the treasury like grains in the granary, or as coins that have come into the treasury in the process of circulation as 'money' *i.e.*, medium of exchange.

The same may be said of the reference to gold in the rule that advises the king to appoint separate officers to look after elephants, horses, chariots, infantry, cattle, gold,[6] jewels, silver, clothes, &c. It is not difficult to appreciate the importance of having separate officers for gold, jewels and silver. But perhaps there is to be only one officer for all these valuables, whether as bullion or as money, as distinguished from other officers appointed for horses, chariots, &c.

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[1] Sukra IV, v, 645. One pala is 8 tolas. One silver pala is therefore Rs. 8.

[2] Sukra IV, v, 649-652.

[3] Sukra II, 106-109.

[4] 1 Muhurta=48 minutes.

[5] Sukra I, 561-562.

[6] Sukra II, 237-238.

That there is to be one officer for these precious metals and stones is clearly indicated in the following lines which describe the qualification of the people in charge of the department: "That man is to be in charge of jewels, gold, silver, and coins who can distinguish their values by their weight, shape, lustre, colour and resemblances." The *mudrâs*[1] or coins may be taken separately as an independent item or as a compound with *svarṇa* and *rajata*, in which case the idea of gold and silver money or currency is unmistakably suggested.

The use of gold in both the functions of money as the standard of value as well as the medium of exchange is also referred to in the following lines:

(1) Houses[2] are meant for gold, jewels, silver, *niskas*[3] or coins etc., and other purposes on which expenditure is technically called *bhogya*.

(2) "*Dravya*[4] (lit. goods) is silver, gold, and copper coined for commercial purposes." The term 'Dravya' may be taken to be the equivalent of what is technically called 'Money.'

(3) "Silver, gold and other booty[5] belong to him who wins them. The ruler should satisfy the troops by giving them those things with pleasure, according to the labour undergone.

Uses of Gold.

Besides the mention of gold as ornaments, valuables and coins, we meet with its use for various other purposes. Thus among the ten requisites in the administration of justice[6] there is the mention of gold which is intended to be the material by which the witnesses are to swear oaths. There is here a religious significance pertaining to the noblest of all metals. Gold is also one of the metals used in the preparation of badges,[7] sceptres, &c. The king should mark those who have been his employees by the proper insignia of office placed on steel, copper, bell-metal or bronze, silver, gold and jewels. Again, two men bearing gold sceptres[8] are to be on one side to communicate the presence and salutation of persons to the king.

Then there is the reference to its use in sculpture. Thus just as there are special stones[9] appropriate to each Yuga to be used as materials for the images of gods, so we have the rule that Images are to be of gold, silver, copper, and bell-metal or bronze in the satya, tretâ, dwâpara, and kali ages

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[1] Sukra II, 303-304.

[2] Sukra II, 692-3.

[3] Sukra IV, ii, 205. Niṣka has a technical meaning. It is the value of gold weighing 4 *mâṣâs*, or 32 *ratis*.

[4] Sukra II, 712-73. Cf. Jayaswal in the *Modern Review* for November, 1913.

[5] Sukra IV, vii, 749-750.

[6] Sukra IV, v, 72-73, 79.

[7] Sukra II, 853-855.

[8] Sukra I, 722.

[9] Sukra IV, iv, 310-311, 314.

respectively. The order of metals as given here is certainly according to its depreciation in value and people's estimation.

The State in relation to Gold.

Certain socio-economic and socio-political laws or regulations with regard to gold are to be noticed. First, without the permission of the king the following things are not to be done by subjects, *e.g.* gambling, use of arms, sales and purchases of gold,[1] silver, jewels, poisons &c. Trade in precious metals and stones cannot thus be carried on without a license. Here is another instance of Sukrâchâryya's advocacy of State Intervention in Industry. Socondly, as we noticed before, those who prepare ornaments of gold,[2] jewels, &c., are mentioned among the artists and artisans who should be maintained by the state. Thirdly, the rate of royalty upon gold[3] mining is declared to be one-half of the produce after the expenses have been met.

Fourthly, those who use others' dress, ornaments and gold are guilty of offences called *chhalas*[4] against the moral sense or social etiquette of the community.

Fifthly, those who deal in gold,[5] grains, and liquids collectively will have earnings according to the amount of their share greater, equal or less. Here is a reference to the joint-stock system or collective organisation in connexion with commercial enterprises, and the rule applies to the dividend of shareholders. The same rule applies not only to commerce and trade as given here, but also to joint-stock industries and handicrafts. Thus "the goldsmiths should get remuneration according to the labour undergone by each in cases where they combine[6] to perform a work of art."

Lastly, we have an idea of the rate of remuneration at which the artists are to be paid who work in gold, *e.g.*, for the manufacture of ornaments, seals, emblems, badges, images, sceptres[7] coins, &c. Thus we are told that the goldsmith's[8] wages is to be one-thirtieth the value worked upon if workmanship be excellent, one-sixtieth if mediocre, and half of that if of inferior order. Wages is to be half of that in the case of *kataka* (bracelet), and in the case of mere melting, half of that. And we have noticed previously the tests by which people are to be protected from metal-workers' fraud.[9] There is at least one reference to the character of goldsmiths. Thus it is said that "goldsmiths[10] are the fathers of thieves." Of course, *all* metal-workers are meant.

Exchange-Value.

Last but not least in importance are the references in *Sukranîti* to the comparative values and "prices" of the metals, *i.e*, their values in terms of

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[1] Sukra I, 603-608.
[2] Sukra II, 397-398.
[3] Sukra IV, ii, 233-235.
[4] Sukra IV, v, 151-152.
[5] Sukra IV, v, 614-615.
[6] Sukra IV, v, 603-604.
[7] Sukra I, 722.
[8] Sukra IV, v, 653-655.
[9] See the reference to the amounts of material that are lost or increased in workmanship. IV, v, 645-652.
[10] Sukra IV, iv, 88.

"money," and their "exchange-value" not only with regard to themselves, but also with regard to other commodities. The distinction between wealth (*Dhana*) and money (*Dravya*) is certainly known to the statesmen of the Sukra cycle. We have noticed above the recognition of the distinction between bullion and coin in *Sukranîti*. The 'unit' of currency and monetary measurement as well as prices and other allied subjects will be discussed in the chapters on the *Data of Ancient Indian Economics* and *Public Finance*.

It may be noticed here that both gold and silver seem to be mediums of exchange and "legal tender" in *Sukranîti*. Prices are mentioned sometimes in terms of gold, often in terms of silver. "Eight *ratis* make one *mâṣâ*, ten *mâṣâs* make one *suvarṇa*.[1] Five times that *suvarṇa* make eighty silver *karṣakas*." The Suvarṇa and Karṣaka are gold and silver *coins* respectively, and one Suvarṇa is equivalent to sixteen Karṣakas. The same ratio[2] is also noted by Sukra in determining the comparative value of gold and silver as bullion or ingot. Thus "the value of gold' is sixteen times that of silver."

The face-value and metallic value of the gold coin were the same in the mediæval Chola Empire (800—1200 A.D.) The statement in *Sukranîti* can be well illustrated by the following extract from Aiyangar's *Ancient India*: "The unit of currency was the gold *Kâsu* (28 grains Troy). This coin appears to have passed for its metallic value, because the great Râjarâja got all gifts to the temple carefully weighed and appraised. All gold ornaments among these are entered with their weights alone, but no value is given, while jewels set with brilliants, etc., are entered with their weights and their value in *Kâsu*. We can safely infer that the *Kâsu* passed for its weight in gold, although its value in grain and cattle might vary."

In 1883, *i.e.*, about thirty years ago, Dr. Râmâdâsa Sen noticed the ratio of gold to silver to be 1 to 20. To-day it is about 1 to 24. There has thus been a great decline in the value of silver *as money*, *i.e.*, a falling off in the purchasing power of silver coins since the days of Sukrâchâryya. It would be an interesting study in Indian Economic and Financial History to find out the epoch or epochs when the ratio given by Sukrâchâryya held good. That would go a great way in fixing the age of the portions of *Sukranîti* referring to the currency.[4]

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[1] Sukra IV, ii, 138-139.

[2] It would thus be evident that both nominal or "face" value and intrinsic or "real" value of the coins are the same. There is no law artificially regulating the price of the coins and the precious metals. The market value of the metals (as indicated by the relation between gold and silver as bullion) was maintained in the currency.

[3] Sukra IV, ii, 161.

[4] This will be dealt with in a subsequent chapter. Statistics given in Brihat Saṃhitâ (6th cent.), Yuktikalpataru (11th cent.), and Ayeen Akbari (16th cent.), would supply valuable materials for a history of Indian Prices. The Bengali work of the 17th century, the *Kavi-Kaṅkaṇa-Chandi*, and *Seir Mutaquherin* of the 18th century are also important documents of socio-economic history.

According to Dhâtukriyâ, a Tantric work of the 16th century, Mahâdeva enumerates to Pârvati the following places as sources of gold and auriferous ores: *Pâvakadri* (?), seaside countries, Sindhu, Kâmarûpa, &c.

ii. *Silver.*

Like the sun and the moon, gold and silver have been mentioned in *Sukraniti* almost as twins. References to the two metals have been made together both explicitly as well as implicitly. Thus our information about silver is nearly the same as about gold, whether as regards (1) examination as to genuineness, or identification, (2) the uses as money *i.e.* standard of value and medium of exchange, (3) the socio-economic and socio-political regulations, (4) the uses in decorative or useful arts, (5) the rates of royalty upon mining and (6) wages to artists, or as regards (7) the circulation as 'legal tender.' The Sukra statesmen have supplied us with parallel facts on all these points in connexion with the two noblest of metals. The following account deals with the remarks about silver.

The examination[1] of silver need not detain us for it is the same as that of gold and other metals.

The wastage or increment of silver inevitable in the industrial processes are known by the following rules: (1) "Silver is diminished by four-hundredth part[2] when melted; if it is otherwise, the artisan should always be punished by the king. (2) In articles of best workmanship silver is lost by a hundredth part; and if soldered by a good material the weight is increased by a sixteenth part.

Silver[3] is mentioned along with gold (1) as a valuable commodity or as coins to be studied by the king for four *muhurtas* before meals, (2) in connexion with the appointment of officers[4] in charge of jewels and coins, (3) in connexion with expenditure on houses that are meant for valuables,'[5] (4) in the definition of *dravya*[6] or 'Money,' and (5) as booty[7] to be distributed among the soldiers by the king.

Besides the uses of silver as ornaments, valuables and coins, we find references in *Sukraniti* to the metal being used (1) in the preparation of badges[8] by which officers are to be distinguished, and (2) in the construction of images in *Tretâyuga*.[9]

The socio-economic laws regarding silver are also the same as those for gold. Thus (1) trade in silver[10] cannot be carried on without a license. (2) The rate of royalty upon silver[11] mining is declared to be one-half of the produce after the expenses of extraction have been met. (3) The references to (*a*) *chkalas* and (*b*) joint-stock organisation are implied,[12] though silver has not been

[1] Sukra IV, ii, 178-179.
[2] Sukra IV, v, 646-47, 649-652.
[3] Sukra I, 561-562.
[4] Sukra II, 303-304, 237-238.
[5] Sukra II, 692-693.
[6] Sukra II, 712-713.
[7] Sukra IV, vii, 749-750.
[8] Sukra II, 353-55.
[9] Sukra IV, iv, 314.
[10] Sukra I, 603-608.
[11] Sukra IV, ii, 233-235.
[12] Sukra IV, v, 151-152, 614-615.

definitely mentioned. (4) The rate of remuneration for the artist is given below : The silversmith's wages[1] is to be half of the material worked upon, if workmanship be of the highest order, half of this if mediocre, half of that if inferior, and half of that in the case of *kataka* (bracelet). In the case of the craft conducted on joint stock principles, the silversmiths are to be governed by the same rule as goldsmiths.[2]

The silver coin is called *karṣaka*,[3] sixteen *karṣakas* make one *suvarṇa* or gold coin. The ratio of silver to gold *as money* is exactly the same as that *as bullion*. Thus "the value of gold is sixteen times that of silver.[4]" The comparative value of silver and copper is also given. "The value of silver is almost eighty times that of copper." The financial and economic questions[5] connected with the metals will be dealt with in a separate chapter.

It now remains to note one remark about silver which the Sukra authors have not made regarding gold or other metals. "The king should daily receive from the sales of silver[6] one-fifth, one-fourth, one-third or one-half—not more" It is difficult to see the propriety of this, since the royalty on mining has been once described and since the duty on sales has not been mentioned as regards other metals.

The following extract relates to the antiquity and history of silver-extraction in India :—

"Solomon is said to have hired fleets of ships from Tarshish for the purpose of obtaining from Ophir the silver used in decorating his palace and temple. The latter place has been identified by some writers as a port or district on the Malabar coast; but at least it is undoubted that Pliny, who wrote A.D. 77, referred to India as a country whence silver was obtained for the use of the Romans.[7] * * * There seems good reason to believe that the Chinese obtained silver from Malabar. * * * In the *Ayeen Akbari*, written about the end of the sixteenth century, silver mines are mentioned near Agra and in Kashmir. * * * Tavernier in his *Travels* says in one passage that Japan is the only Asiatic country where silver occurs, but afterwards cites Bhutan and Assam as possessing silver mines."

iii Copper.

The examination of copper has to be conducted according to the same method as that of gold and silver. The wastage[8] of copper in industries amounts to one-hundredth part.

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[1] Sukra IV, v, 656-657.

[2] Sukra IV, v, 603-604.

[3] Sukra IV, ii, 189.

[4] Sukra IV, ii, 181, 182.

[5] For Indian Numismatics, see the *Historical Volume*, and for Modern Indian Currency and Prices, see the *Economic Volume* of the *Indian Empire* in the *Imperial Gazetteer Series*.

[6] Sukra IV, v, 643-644.

[7] *Dictionary of the Economic Products of India*, Vol. VI, Part III, pp. 288-343.

[8] Sukra IV, v, 647.

Copper is not mentioned as a valuable to be hoarded nor as a material for ornaments. Badges,[1] however, are made of this material. Images[2] of gods also are construeted out of copper in *Dwâparayuga*.[3] The rate of royalty upon copper mining[4] is one-fourth of the produce. The coppersmith[5] is to get one-fourth of the value worked upon as wages.

Copper coins are mentioned in the definition of Dravya or 'Money' along with gold and silver (II, 712-713). A *paṇa*[6] is a piece of copper coined by the king weighing ten *mâṣâs*. The following comparative values[7] define the position of copper in the scale of prices: "The value of silver is eighty times that of copper. The value of tin is one and a half times that of copper, that of zinc twice that of tin, *i.e.*, thrice that of copper, that of lead thrice that of tin, *i.e.* four times and a half of that of copper, that of iron six times." Excluding cowries, copper coin is thus of the lowest value in the realm, gold being the highest and silver intermediate. The currency questions will be discussed in a subsequent chapter along with the historical significance of the prices.

It remains now to note that among artisans to be 'protected' by the king we find the mention of coppersmith;[8] and that copper is a constituent[9] of two alloys: (1) bell-metal or bronze, together with tin, and (2) brass, together with zinc.

In the *Dhâtukriyâ* of the sixteenth century, the following places have been enumerated as the sources of copper: Nepal, Kâmarûpa, Bangala, *Madaneswar*(?), *Gangâdwâra*(?), *Malâdri*(?), the country of the Mlechchhas, *Pâvakâdri*(?), Rûma (Constantinople), the country of the Phirangas (Portuguese and Europeans).

Mr. Medlicott, F. R. S., gives the following distribution of copper in the *Dictionary of Economic Products of India*: Singhbhum, Dhalbhum, Hazaribagh, Rajputana States, Ajmir, Afghanistan, Kumaon, Gharwal, Darjiling, Western Duars, Kurnul and Nellore.

"In ancient times copper mines were worked on a larger scale than at present."

The importance of copper in Hindu religious ceremonies is thus described in the *Journal of Indian Art*:[10] "Fine shrines for the god, with excellent flower-carvings; dishes or platters with tanks or lotus patterns nicely worked out; the pedestal for the placing of the image during the sacred bath; the vessels except when the worshipper is rich and can afford silver ones, and everything connected with the performance of Hindu worship are made of copper."

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[1] Sukra II, 853-855.

[2] For copper in Indian Art, see Vincent Smith's *History of Fine Art in India and Ceylon*, pp. 171-172, 198, 364. *Vide* also Birdwood's *Paris Universal Exhibition*, 1878, pp. 61-2 (Std. Edition).

[3] Sukra IV, iv, 314.

[4] Sukra IV, ii, 233-235.

[5] Sukra IV, v, 658-659.

[6] Sukra IV, i, 233.

[7] Sukra IV, ii, 182-184.

[8] Sukra II, 399.

[9] Sukra IV, ii, 176.

[10] P. 29, Vol III, No. 29.

iv. Iron.

Iron is an important substance, though it is not used as material for coins. The list of 64 *kalâs*[1] or practical arts, as well as the enumeration of the artisans[2] and artists to be maintained by the state, indicate the place that iron occupies in Industrial life. We may note that iron-images[3] are also recommended.

The wastage[4] of material involved in workmanship amounts to one-eighth part. The wages[5] of the blacksmith may be half of, or equal to, or twice or eight times of, the value worked upon. The rate of royalty[6] is one-sixth of iron upon the produce after the expenses have been met.

Among the industries[7] in which iron plays a conspicuous part are those connected with warfare. The arms and weapons, chariots and ordnances all require the use of iron. The Sukra authors have noticed it. Needles and razors have also been mentioned. We are also told that even the hard iron can, by proper methods, be converted into a liquid.[8]

The value of iron[9] is six times that of copper.

In his *Handbook to the Indian Court*[10] at the Paris Universal Exhibition of 1878, Sir George Birdwood remarks: "Iron is frequently mentioned in the Bible under the Hebrew name of *paldah*, which is the Arabic *fulad*, and indicates Indian iron." And Mr. E. B. Havell[11] is of opinion that in the use of steel "Hindu craftsmen had no rival until quite modern times," and refers to the notes on the use of wrought-iron girders in Orissan temples in *Orissa and her Remains* by Mr. Manomohan Ganguly, B. E.

The following gives the geographical distribution of iron ores according to Dhâtukriyâ (16th century): Lohâdri, Gayâdri, Gautamâdri, Vindhya, Nalâdri, Tryamvaka, seaside places.

v. Tin.

Information about this metal is very small in *Sukraniti*. We are told that the wastage of the material in industrial processes amounts to one-sixteenth part.[12] The rate of royalty upon tin-mining[13] is one-sixth of the produce after the expenses have been met. The workman's remuneration[14] is one-fourth of the value worked upon. We are not told what are the industries in which tin plays a part, except that together with copper it makes the

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[1] Sukra IV, iii, 132-200.
[2] Sukra II, 393-411.
[3] Sukra IV, iv, 317.
[4] Sukra IV, v, 646-648.
[5] Sukra IV, v, 658-659.
[6] Sukra IV, ii, 233-35.
[7] See references to chariots (IV, vii, 60-63), nâlikâstras (IV, vii, 389-394), cannon-balls and bullets (IV, vii, 407-408), gunpowders (IV, vii, 411-15), and the weapons (IV, vii, 422-34).
[8] Sukra IV, vii, 588-90.
[9] Sukra IV, ii, 183-184.
[10] Second Edition p. 28.
[11] Indian Architecture, p. 122.
[12] Sukra IV, v, 646-648.
[13] Sukra IV, ii, 233-235.
[14] Sukra IV, v, 658-659.

alloy bell-metal[1] or bronze. The proportion of the constituents is not stated. The value of tin[2] is one and a half times that of copper.

India is not naturally rich in tin-ores, the deposits "being more of mineralogical than practiceal interest; as modern geological surveys indicate. In certain parts of the Malaya Peninsula and Burma, however, rich deposits of tin-stone occur." Oldham and Ball have described these occurrences in Further India.

Says Dr. Watt[3] "tin has been known in India from a very remote period, and early held an important place in Sanskrit Materia Medica, being mentioned by Susruta. The supply was probably obtained from Burma or from some of the tin-producing islands of the Malaya Archipelago; between which and India trade must have existed in very ancient times."

But, as we have seen, tin was familiar to the Hindus even in Vedic times. The connexion (commercial, and also political) between India and Further India must therefore be inferred to have existed so early as that. And according to Birdwood,[4] "Homer mentions tin by its Sanskrit name *Kastira*; and the Phœnicians, who first learnt the name from the trade through the Arabs with India, afterwards gave the name of Cassiterides to the Scilly islands and Cornwall where it still survives in Cassiter street, Bodmin."

vi. Lead.

Information about lead in *Sukranîti* is as meagre as that about tin, though it is slightly greater. Thus we are told that lead-images[5] may be constructed for religious purposes; and that lead may be used for cannon-balls[6] and also as an ingredient of gunpower.[7]

The wastage[8] of material in industrial processes amounts to one-sixteenth part, the artisan's remuneration is not mentioned. The rate of royalty upon lead-mining is one-sixth of the produce after the expenses of extraction have been met. The value of lead is thrice that of tin *i.e.*, four times and a half of that of copper.

The geographical distribution of lead is thus given in Dhâtukriyâ of the 16th cent.: Nepâla, Kedâra, Karmakânda, Tryamvaka, Tripura.

"Although at the present time lead ores are not largely worked in India, Ball[9] states that there is probably no metal of which the ores have been worked

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[1] Sukra IV, ii, 176.

[2] Sukra IV ii, 183.

[3] See *Dictionary of the Economic Products of India*, Vol. VI, Part IV, pp. 57-62. On the authority of Dr. U. C. Dutt, Dr. Watt traces the antiquity of tin to Susruta. But for recent researches, see Macdonell and Keith's *Vedic Index*, I, 31, 326.

[4] *Paris Universl Exhibition* (2nd Edition), p. 28. Mr. Schoff, however, believes *Kastira* to be a non-Sanskrit word, cf. *Periplus*, p. 79.

[5] Sukra IV, iv, 317.

[6] Sukra IV, vii, 407-408.

[7] Sukra IV, vii, 411-415.

[8] Sukra IV, v, 646-48.

[9] *Dictionary of Economic Products of India* (1890), Vol. IV, pp. 602-3.

to so large an extent in ancient times, excepting those of iron. This is testified to by the number of old mines in Southern India, Râjputana, Baluchistan, and Afghanistan."

According to Mr. Schoff's *Periplus*,[1] "Lead and Tin are mentioned in the *Artha Śâstra* as alloys used in coining."

vii. Zinc.

We have already noticed several important points in connexion with the use of zinc in India under the heading of the *Doctrine of Seven Metals.*

The wastage[2] of material in industrial processes amounts to one-sixteenth part. The remuneration[3] of the workman is one-fourth of the value worked upon. The rate of royalty upon mining is not given. Its value is twice that of tin, *i.e.*, thrice that of copper.[4] It enters into the composition of the alloy brass,[5] together with copper; but the proportion of the constituents is not given.

Dhâtukriyâ, a Tantric work of the 16th century, enumerates the following sources of zinc: *Kumbhâdri*, Kâmboja, Rûma, Balkh, Bangala.

"Zinc, according to Mr. Dampier,[6] "appears to have been introduced into Europe from India, whence, as in the similar case of muslin and calico, it has returned in such volume as to oust the original native product.

"Zinc[7] occurs in nature, in combination with sulphur, forming the sulphide or zinc *blende*, with oxygen forming *zincite*; and more rarely as a silicate, carbonate, sulphate or arsenate. * * * "The only considerable deposit of zinc ores, which has been extensively worked in the peninsula, occurs in this region (Râjputana) at Jawar in the Udepur State. * * * In Colonel Tod's *Râjasthan*, the mines are alluded to incidentally as having yielded an annual revenue of Rs. 2,22,000. * * * The mines were closed during the famine of 1812-1813 and have not since been re-opened. The ore appears to consist chiefly of zinc carbonate."

Mr. John Henry Pepper in *The Play-Book of Metals* gives the following history of zinc in the west: "The metal was not known to the ancients, although they were acquainted with the mineral cadmium or calamine; and without it they could not have made brass. Hesiod states that 'in remote ages the earth was filled with brass implements of agriculture, because iron had not been discovered.' The use of calamine in the composition of brass was known to Aristotle, who makes a distinction between the compound resulting from the mixture of copper and calamine and that resulting from the mixture of copper

[1] P. 221 (Longmans, 1912).
[2] Sukra IV, v, 646 648.
[3] Sukra IV, v, 658-659.
[4] Sukra IV, ii, 183-184.
[5] Sukra IV, ii, 176.
[6] *Monograph on Brass and Copper wares* (1894), p. 21.
[7] *Dictionary of the Economic Products of India*, Vol. VI, Part IV (1893), pp. 356-357.

and tin.[1] * * * Zinc appears to have been first called by that name in the writings of the madly-Zealous Paracelsus, about the year 1540."

We have seen previously that zinc has been mentioned by the Hindus as a separate metal by King Madanapâla of Kanauj in 1374.

(*b*) *The alloys.*

Two alloys[2] are mentioned in *Sukraniti*: (1) kâmsya which may be either bronze or bell-metal, and (2) pittala or brass.

Kâmsya is the alloy of tin and copper, in what proportions, it is not stated. It is mentioned (1) as one of the materials that may be used in the manufacture of badges[3] by which the officers of the state are to be distinguished from one another; and (2) as the material to be used in the construction of images[4] for the *Kaliyuga*.

We are not supplied with any information as to the duties on commercial transactions, the rate of remuneration of the workmen, &c., as we are not told anything about the other alloy.

"Brass and bronze play in the Hindu household as important parts as glass and china wares among the western nations.[5] * * The Hindus influenced strongly by a * * feeling against using earthen and wooden wares, have been using from time immemorial, brass and bronze wares for domestic purposes, and copper ones on ceremonial occasions."

The treatment of brasses and bronzes in mediæval Hindu art has been described by Mr. Vincent Smith[6] in connexion with South Indian workmanship. He has given illustrations of brass portrait images of Krishnarâya of Vijayagara (A.D. 1510-29) and his queens, Natarâja or dancing Siva from Tanjore, the Bronze Pârvati (12th cent), bearded Râmchandra in bronze (18th cent. ?) and plunging horse in bronze cast. Mr. Smith also refers to the many-sided genius of Vitapâla, the East Indian worker in bronze and stone, of Pâla times.

SECTION 9.

General remarks on Gems in Sukraniti.

Pearls have been fished along the Coromandel Coast from long before the time of Alexander's invasion. Pearls, precious stones and gold have been known in India as elements of ornament from time immemorial. Manu ordains a fine for piercing fine gems as diamonds or rubies and for boring

[1] Edition of 1861, pp. 494-95. See also *Encyclopædia Britannica* (11th Edition), Vol. 28, p. 981.

[2] Sukra IV, ii, 176. *Vide* Birdwood's *Paris Universal Exhibition*, 1878, pp. 61-63.

[3] Sukra II, 853-855.

[4] Sukra IV, iv, 814.

[5] The *Decline of South Indian Arts* by Pandita Natesa Sastu in the *Journal of Indian Art*, Vol. III, January 1890.

[6] For bronze as a material in Indian Art, see Vincent Smith's *History of Fine Art in India and Ceylon*, pp. 179-180, 286, 266-7, 305-7.

pearls or inferior gems improperly. Rajendralal quotes *Mrichchhakati* or "Troy-Cart" of the 1st cent. B. C. to show that the author Sudraka did not think it inconsistent to describe, in the courtyard of a common courtezan's house, jeweller's shops, "where skilful artists[1] were examining pearls, topazes, sapphires, emeralds, rubies, lapis lazuli, coral and other jewels; some set rubies in gold, some work gold ornaments on coloured thread, some string pearls, some grind the lapis lazuli, some pierce shells, and some cut coral." Nor were the people satisfied with such originals; the requriments of society rendered the fabrication of false jewellery a commonly practised art, in fact, one of the 64 *Kalâs* according to Sukrâchâryya.

The authors of Sukra cycle have mentioned jewels and precious stones mainly as valuable articles of commerce. As such, references to these in Sukranîti are parallel to the remarks about gold and silver, the two noble metals. Sometimes of course the word *ratna* or gem is used metaphorically when it includes the noble metals as well. There is at least one remark of Sukra which takes the term metaphorically and gives reasons also. "Those which are rare in this world are priced as gems."

As valuable commodities, the gems are hoarded in the treasury and demand the king's attention of four muhurtas[2] before meals. They require a special officer[3] to look after them with the qualifications of a mineralogist, who can detect the false stones and select the genuine ones. Special houses that are to be built for them are erected at a cost which is technically known as *bhogya*.[4]

The definition of *dravya*[5] or 'Money' includes not only the metallic coins but also gems and cowries. The custom of distributing booty[6] among the soldiery applies to gems also, though they are not distinctly mentioned. Jewels like metals may be used to serve the purposes of badges[7] meant for distinguishing between officer and officer. Trade in jewels[8] is forbidden without a charter or license. Like the goldsmiths, coppersmiths and other metalworkers, artists[9] and artisans in gems and jewels also deserve encouragement and "protection" of the state.

The use of jewels belonging to some other person is one of the *chhalas*[10] or social offences recognised by the state. This is to be guessed from the description of the offence with regard to gold and ornaments. Similarly also, the rule about dividends of joint enterprises[11] and collective dealings in precious stones, is to be inferred from that with regard to gold, grains and liquids.

We have been told that jewellers should be patronised by the state, but information as to the rate of remuneration is not available. The rate of

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[1] Wilson's *Hindu Theatre*, II, 85.
[2] Sukra I, 561-562.
[3] Sukra II, 303-304, 287-288.
[4] Sukra II, 692-693.
[5] Sukra II, 712-713.
[6] Sukra IV, vii, 749-750.
[7] Sukra II, 853-855.
[8] Sukra I, 603-608.
[9] Sukra II, 397-398.
[10] Sukra IV, v, 151-152.
[11] Sukra IV, v, 614-615.

royalty, however, is mentioned It is declared to be half of the *net* yield of precious metals, *i.e.*, after the expenses of extraction and production have been met. The realisation of Government revenue from *ratnas*[1] is important enough to be recognised as an item that should be studied by the *Sumantra* or Finance Minister. Besides the revenue accruing regularly from the *âkaras* or mines, Sukrâcharâyya's system of Public Finance recognises *Ajnâtaswâmika*[2] income. It is that wealth whose owners are unknown. Gems and jewels (*Nidhi*) picked up in streets escheat to the state and constitute this class of income.

Among property laws it is mentioned that the father is the lord of all gems[3] etc., but neither the father nor the grand-father has authority over all immovables. This is a regulation about *all* precious movables.

We have thus far noted the parallelism between gems and noble metals as valuable commodities. The fraud that may be committed with regard to them, *e.g.*, by the passing off of imitation jewels as genuine ones has also to be noticed It is mainly to guard the treasurer, the minister of Public Finance and the king as well as the people that the Sukra statesmen have introduced the topics of Economic Mineralogy in their *Nitisâstra*. If it is the ornament of jewels to have splendour,[4] and if it be a general custom to present jewels and ornaments[5] to females at marriage, it is necessary that people should have the eye to find out what is the proper splendour of a jewel. Besides, there are natural defects[6] in gems. It is known also that people of the island of Ceylon can make artificial[7] pearls, The making of artificial gems[8] is in fact known to be a *kalâ*. Like the testing of gold and other metals, therefore, testing of gems as to whether they are good or bad, as possessing marks or holes, has been recognised as a *kalâ*. The advice to rich people and kings necessarily is: "The wise man should determine their value by carefully examining[9] them." "The king should keep the jewels after having them tested by experts as well as by himself."

The following general rule may help people in testing the worth of precious stones: "Those who are experts in the study of gems describe that gem as the best which has no pores,[10] has good colour, is without scratches and spots, has good angles and bright lustre."

The general information about colour and shape is being made more clear in the following lines:[11] (1) "Gems (*a*) may have the colour of *sarkara* (powdered bricks) or leaves of trees, and (*b*) may be flat or round in shape; (2) "The colour and lustre of gems may be white, red, yellow and black."

There are two technical terms[12] here used in connexion with the splendour of precious stones, *viz.*, *Chhâyâ* and *Prabhâ*. The terms have been defined

[1] Sukra II, 211-212.
[2] Sukra II, 656-657.
[3] Sukra IV, v, 577-578.
[4] Sukra II, 468-479.
[5] Sukra IV, ii, 171.
[6] Sukra IV, ii, 124.
[7] Sukra IV, iii, 178.
[8] Sukra IV, iv, 21-22.
[9] Sukra IV, ii, 171-172, 79-80.
[10] Sukra IV, ii, 97-98.
[11] Sukra IV, ii, 99-100.
[12] Sukra IV, ii 108,

by Sukra thus: (1) "The *Chhâyâ* is that which attacks,[1] overpowers, and eclipses the colour (of other substances)." (2) The *Prabhâ*[2] is that which reveals the colour (of other substances). Prof. Ray in *Ratnaparikṣâ* explains the remarks of Sukra in the following way: The light of a lamp does two things simultaneously: (1) It removes the darkness and makes other objects visible, *i.e*, makes it possible for them to display their colour and attributes (2) It prevents like objects, *e.g.*, white paper or milk, from displaying their proper colour and attributes. The first function of the lamp is due to its lustre or *prabhâ*, the second is due to its *chhâyâ*. The light issuing from a lamp or a jewel may thus be divided into two branches—(1) *reflected*, which makes other things visible, (2) *transmitted* which eclipses other objects.

As for the value of precious stones, Sukra statesmen know that it depends on both Demand and Supply. Omitting from one's consideration the factors that go to make "Demand-Schedule," as it is called by Professor Marshall, we may note the following conditions on the Supply side. These conditions[3] give in fact additional tests by which the splendour, lustre, and beauty of jewels are to be determined, and the considerations which weigh much in people's estimation :—

(1) Other things remaining the same, the "exchange-value" of a gem depends on its weight, lustre, colour, extent, receptacle and shape.

(2) Other things remaining the same, the 'exchange-value' increases if there be great bulk with small weight, and decreases if there be small bulk with great weight.

(3) Other things remaining the same, 'exchange value' is smallest if the lustre be that of *sarkara* (reddish powder of bricks); is middling if the shape be flat; and greatest if the lustre be that of green leaves.

(4) Other things remaining the same, round jewels are not much appreciated and their 'exchange-value' depends on the "Demand-Schedule."

The following information about gems recorded by the authors of the Sukra cycle is useful:

(1) The gem on the head of the snake[4] is the best of all, of great splendour, but very rare. The tradition is old enough. The real explanation of gems lying in the heads of snakes is that these creatures carry bright stones in their mouths when they have to move in the dark. These they pick up from stocks and stones in hills and mines and forests. When they get their prey, they throw these jewels away from their mouths for a time, and carry them again as lamps to point out their way, when they have finished their work at the spot.

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[1] This is the explanation of Prof. Yoges Ch. Ray. The reader is requested to note the difference from my translation of the hemistich on p. 141 of the Sacred Books of the Hindus Series XIII.

[2] P. 24, Edition of 1904.

[3] Sukra IV, ii, 107-114.

[4] Sukra IV, ii, 96.

(2) Except pearls and corals the gems cannot be cut or written upon[1] by iron and stones (diamonds). This is said by those who are experts in gems.

(3) The value of gems is measured by weight.[2]

(4) One should receive knowledge, *mantra*, medicine, wife and gems[3] even from low families. This general rule of morality may be compared to Chaṇakya's[4] adage that one should take gold from even the impure (persons or places), the jewel of a wife from even low families, and good (useful) knowledge from even the lowborn. It is implied that medicines, gems, &c., were in Sukra's days, as in ancient Hindu times generally, dealt in by the low class men. Here is the sanction that these things may be accepted from persons, who, otherwise beyond the pale of high society, are, however, experts in their subjects.

(5) The gem that has its appropriate colour and lustre and is devoid of any defects is beneficial to beauty,[5] growth, fame, valour and life. Others are known to be injurious. This notion about the efficacy of precious stones obtains with regard to noble metals also, and has had its sway since time immemorial, both in the Eastern and Western worlds. The story of the Talisman is well-known, and we have already quoted extracts from Vedic literature bearing on this point.

(6) The above general idea has been crystallised by Sukra sociologists into a definite maxim of sound health. Thus we are told (*a*) that one should always use medicinal substances in jewels[6] consecrated by charms or mantras. (*b*) One should never wear gems that have black or red spots.[7]

(7) Gems found in the Gandaka[8] river are natural images, and need not be given to the sculptor to try his skill upon. And we are told that, whereas in the case of images constructed by artists one should thoroughly examine their parts and proportions according to the canons of *Silpasâstras*, these and other natural stones should not be examined at all.

(8) Gems never lose their natural attributes. These cannot deteriorate. But pearls and corals can. It is only the wickedness of kings[9] that leads to fluctuation in their exchange-values.

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[1] Sukra IV, ii, 109-110.

[2] Sukra IV, ii, 129, *Gomeda is* the exception. It is not to be weighed, being very insignificant. The standard of measurements of precious stones is given in Sukra IV, ii, 130-133.

[3] Sukra III, 193-194.

[4] Amedhyâdapi Kâñchanam,
Nîchadapyuttamâ vidyâ Stri ratnam duskulâdapi.

[5] Sukra IV, ii, 101-103.

[6] Sukra III, 8-9.

[7] Sukra IV, iv, 307-308. Such other natural images are *Vanalingas*, *Chandrakântas*.

[8] Sukra IV, ii, 115-116.

[9] Sukra IV, ii, 156.

Section 10.

The Doctrine of Nine Gems.

Nine is a mystic number like seven. In Indian thought we have the tradition of nine planets, nine gems, nine nights (called *navarātra*,[1] meaning thereby the sacrificial rite that is finished in nine days or nights), nine *rasas* (or feelings and emotions, *e.g.*, amorous, ludicrous, pathetic, vehement, heroic, terrific, loathsome, absurd, and peaceful, according to Hindu canons of literary art), the nine *lakṣaṇas* (or marks of Brahma) according to Vedānta Paribhāṣā, the nine *Saktis* (or energies), the nine castes (of the Sudra order, according to Parāśara Samhitā), the nine doors (*e.g.*, two eyes, mouth, etc., of the human organism), the nine islands of the Ganges (which, according to the Vaiṣṇava poet, Narahari Dāsa, formed the site of what in later times has been Navadvīpa or Nadia, the land of Chaitanya), also the nine tests of Kulinism propounded by king Ballāla Sen of Bengal (12th cent.).

The doctrine of nine gems, like that of the seven metals, has an interesting history. Indian tradition has taken the nine gems both literally and metaphorically. In this latter aspect we have it when we refer to the strong popular notion about the "Navaratna"[2] of the court of Vikramāditya. The legends of Vikramāditya cycle, like those connected with Alexander, Arthur and Charlemagne in European literature, refer to things that are half-historical, half-mythical. The hero himself, round whom the romances have grown, has not yet been indentified. Some of the incidents connected with Vikramādityan tradition have in these days been ascribed to Samudragupta, the Indian Napoleon, in whose conquest of the four quarters of India, scholars have seen the historic counterpart of the Kalidāsic hero Raghu's *Digvijaya*. We know the age of Samudragupta (4th cent. A.D.), or for the matter of that, of the Vikramāditya of legendary fame, to be one of the most glorious epochs of Hindu culture, one of the Augustan ages of Indian literature. There can be no objection, therefore, to regarding this Gupta monarch as the patron of several groups of nine celebrated intellectual giants,

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[1] See the word *Navaratna* in the Bengali *Viśwakoṣa* (Encyclopædia Indica) edited by Mr. Nagendranath Vasu, Vol. IX, pp. 653-657 (First Edition, 1898). This Volume gives several words beginning with *nava* or nine, which are important as testifying to the tradition. The word *Navanavaka* occurs in Dakṣa Samhitā (III; 3) as a mnemonic for nine groups or classes of householder's duties, each consisting of nine functions. Thus we have nine *amritas* or sweet functions, nine gifts, nine duties, nine forbidden things, nine secret activities, nine successful functions, nine failures, nine public activities, and nine things (not to be given away).

[2] These are Dhanvantari (the physician), Kṣapaṇaka (the philologist), Amarasimha (the lexicographer), Śanku (the elocutionist), Vetālabhatta (the necromancer), Ghatakarpara (the Politician), Kālidāsa (the poet), Varāhamihira (the astronomer), and Vararuchi (the grammarian of Prākrit languages). The couplet containing the names of the nine luminaries of Vikramāditya's court is found in the last chapter of *Jyotirvidābharaṇa* by the astrologer, named Kālidāsa (18th century).

who are figuratively known as the *Navaratna.*[1] But Indian chronology cannot as yet bear out the tradition that the great luminaries included in the term *Navaratna* ever shone in the intellectual firmament of India at one and the same time. To take only two instances. If the Gupta monarchs were the patrons of Kâlidâsa,[2] he must be placed between the 4th and 5th century. But Varâhamihira, the astronomer, is now known to have flourished in the sixth century.

Under these circumstances, the easiest explanation would of course be to ascribe the origin of the tradition to the desire of the people for a convenient mnemonic grouping together the greatest makers of national literature, art, and science through the ages, long after the great masters had played their part on the world's stage. The traditions of the seven wise men of Greece and the seven Magi of Persia afford instances of such convenient groupings of men who have lived, if they were really men of flesh and blood, ages apart from each other.

It is posterity that arranges, classifies, and systematises the exploits of the predecessors. Human memory in reconstructing the history of past generations through the dim vistas of folklores, traditions, myths and fables obliterates[3] the sharp edges of temporal and local differences; and the result is a well-rounded 'system,' a cleverly assorted 'Noah's ark,' a sweet company of 'strange bed-fellows' and a glib enumeration of facts and 'things that never were on sea or land.' Such latter-day recounting and reconstruction of the deeds of the founders of a people's greatness as are improvised for the purpose of helping the national memory and aid in the promotion of race-consciousness are not, however, without deep historical and sociological significance. For these traditions are, at any rate, replete with the associations of the epochs in which they were made and must bear the impress of the general features of the culture of the day.

Thus the metaphorical use of the doctrine of nine gems in Indian traditional thought must be ascribed to an epoch which has long been used to the idea of nine gems literally speaking. The philosophy and history of the metaphorical use must follow the philosophy and history of the tradition regarding the actual stones of the mother-earth.

The enumeration and classification of precious stones, however, have not been uniform in Indian mineralogical literature. The tradition recorded in

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[1] See the discussion in Prof. Wilson's *Viṣṇu Purâṇa* (1864) Vol. I. Preface pages vii—ix.

[2] Pandit Râmavatâra Śarmâ Sâhityâchâryya, M. A., Professor of Patna College, Bankipur, and Dr. Bloch have proved that the author of *Raghuvamsam* and *Kumârasambhavam* flourished during the reign of Chandragupta II and Kumâragupta. For an account of covert references to the Gupta Emperors, see the late Mr. Harinath Dey's English Introduction to the Bengali work on Kâlidâsa by Pandit Râjendranâth Vidyâbhushan (1908).

[3] According to tradition Kṣapaṇaka and Amarasimha were probably Jainas, Kâlidâsa belonged to the agricultural caste and Ghatakarpara was a potter, and so on.

Sukranîti about (1) the nine *mahâratnas* or great jewels (2) their grouping in order of merit into four classes, *e.g.*, (*a*) *Sreṣthatara* or *par excellence*, (*b*) *Sreṣtha* or high class, (*c*) *Madhyama* or middling and (*d*) *Nicha* or inferior, and (3) the astral or mystical connexion of each with one of the nine deities presiding over, or apotheosised out of, the nine planets, is only one phase in the history of Hindu ideas about precious stones and jewels. It may be possible to fix the age of certain passages of the *Nîtisâstra* of the philosophers of the Sukra cycle by tracing the history of this doctrine of nine gems.

From the close connexion of the nine gems with the nine planets it may be presumed at the outset that the origin of the tradition is to be traced to the idea of *navagraha* in the history of Hindu Astronomy. In the following account, therefore, we have to take note of two things:

(1) Changes in the ideas about the enumeration, classification, &c., of precious gems: (*a*) as *navaratna*, and (*b*) as *nava mahâratna*.

(2) History of the navagraha or nine planets: (*a*) as members of the celestial system and (*b*) as influencing things mundane, specially as presiding over the gems.

(*a*) *Vedic Literature.*

In our account of the history of Indian literature on gems we have alluded to the reference in the Vedas. But information is mostly indefinite and vague. It is only the pearls that have been distinctly mentioned, and an account of their origin given. And though jewels, like metals, are used with charms and incantations against the malevolent influences in enemies and demons, we do not meet with any trace of the connexion that exists between gems and the deities, whether powers of nature or planets and stars of the sky.

But Vedic literature is important in the history of Indian mineralogy from at least one point. We have seen that in the Vedas the generic word for metals is not *dhâtu*, but *ayas*, or *loha*. So also the gems and jewels, whether meaning thereby pearls or diamonds, are generally referred to not as *ratna*s, but as *maṇis*, though the word *ratna* does occur in the *Rig Veda*.

(*b*) *Ayurvedic Literature.*

This word *maṇi* for gems holds the ground for long. In Ayurvedic literature we find Charaka and Susruta using this term. In the introductory chapter of his work Charaka mentions *maṇis* among the drugs pertaining to the earth. We have noticed above that no gem[2] has been enumerated by name

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[1] Prof. Yoges Chandra Ray in his learned work in Bengali on the Astronomy and Astronomers of the Hindus testifies to the belief of the people in Vedic times in the influences of stars and planets on human life. "The propitiation of the *navagraha* or nine planets has been sanctioned in the Parisiṣta of Sâma Veda."

At least about 1000 B.C. the fact that the movements of the stars governed the fate of men on earth was understood and explained. (See p. 45—*Edition 1913*). But no definite connexion of stars with jewels or metals is suggested.

[2] See *Charaka Samhitâ*, Sanskrit Text, p. 7 (Edited by Kavirâjas Sen, Calcutta).

in the *Charaka Samhitâ*. So this work also, like Vedic literature, does not throw much light on the doctrine of nine gems.

The information supplied by Susruta is a little more definite. He also uses the term *maṇi* and not *ratna*, and in the chapter on *Food and Drinks* in the Sutrasthâna section of the *Samhitâ* gives the medicinal properties of six gems[1] only. These are muktâ (pearls), vidruma (coral), vajra (diamond), indra (sapphire), vaiduryya (chrysoberyl) and sphatika (crystal).

The word *ratna* must have been always familiar in literary circles, Vedic and post-Vedic. Long before the days of Kâlidâsa, who uses the word frequently, Varâhamihira, who refers to many previous *Ratnasâstras*, and Amarsimha, the lexicographer, who are generally supposed to have flourished between the 4th and 6th century A.D., the gems and precious stones have been referred to by convertible terms, *maṇi* and *ratna*.

It would thus appear that the word *ratna* as a technical term used in scientific treatises has had a longer history than *dhâtu* which, however, as a name of metals, is old enough. The term *loha* has held the ground for a longer period—even in works like Rasaratna-samuchchaya of the 14th century. But the term *maṇi* has allowed its rival *ratna*[2] to flourish parallel to itself and gradually supersede it ever since the times of Buddha, the Epics and earlier Purâṇas.

(c) *Varâhamihira.*

Besides *Susruta*, the only important work that supplies positive information on the enumeration and classification of *ratnas* or *maṇis* during the classical period[3] is that scientific work of the sixth century, the *Brihat Samhitâ* of Varâhamihira. This astronomer like, his predecessors of 1000-1500 years ago, fully believes in the mundane influences of the planets and their movements and begins his work with the following words fathered upon the sage Garga: "That prince meets with ruin who does not support a Jyotiṣaka well-versed in all the divisions and sub-divisions of Samhitâ, and in Horoscopy and Astronomy. * * * If there were no Jyotiṣakas, the muhurtas, the tithis, the nakṣatras * * would go wrong. * * * He who loves prosperity ought

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[1] *Susruta Samhitâ* Edited by Kavirâjas Devendra Nath Sen and Upendra Nath Sen (1900) pp. 221-222. Susruta knows of other *maṇis* as the compound ending in *âdi* or "*etc*" implies; but perhaps does not mention them as they are not much used in medicine. Thus, as Dr. Dutt says in the *Materia Medica of the Hindus*: "of the precious stones, diamond, pearl, and coral only are much used in medicine. The rest are rarely used or not used at all," p. 92, (Edition of 1900).

[2] Messrs. Macdonell and Keith consider the word to denote any precious object in Rigveda, not necessarily a jewel, as later. *Vedic Index* II, 199. The older word *maṇi* seems to be more generic, *ratna* is the word for more precious substances. The word *maṇi* may be taken more widely, in which sense it would include *metals* on the one hand, and gems on the other.

[3] There has been very little critical study in the literature of this period, and very few materials of a historical or sociological character are at present available.

not to live in a country devoid of a Jyotiṣaka. The Jyotiṣaka[1] forms as it were the eye of the land."

Varâha then describes the seven planets and the Râhu, but does not mention the Ketu, the ninth planet. In treating of the influences of the planets Varâha does not notice the connexion that may possibly exist between the *grahas* and the *ratnas*.

When, however, towards the close of his work, he notices the gems enumerating them and describing their characteristics, he does this not because these have any natural relationship with the gems of the firmament, but because, like these celestial orbs, and so many other things in the universe, *viz.*, trees, animals, earthquakes, clouds, &c., they independently govern the destiny of mankind. According to Varâhamihira, whatever directly or indirectly affects human welfare are important items and cannot be neglected in that aspect of Jyotiṣa Sâstra which is being dealt with in *Brihat Samhitâ*. The planets have been discussed because they influence man's destiny. So also the meteorological, agricultural and other phenomena have commanded his attention. The same reasons demand of him space for the jewels and precious stones. Varâha has nothing to do with the propitiation of the planets and does not care to study the gems[2] in their special relations to the planets.

Varâha has mentioned 22 gems, but describes only four in detail:— (1) Diamond, (2) Pearls, (3) Rubies, (4) Emeralds. And he treats of the influences of these as affecting social welfare.

The object of Varâha in introducing the subject of gems[3] in the astronomical work is set forth by him at the outset: "A good gem brings prosperity to the king and a bad one brings misery. It is therefore necessary to examine the properties of gems with the help of persons learned in the science; for a person's fortune depends upon the gems he possesses. Elephants, horses and women possessed of excellent virtues are also known as gems; but diamonds and the like gems which are to be treated of in this chapter are stones and the like, possessed of many excellent qualities."

The treatment of gems in *Brihat Samhitâ* is thus quite independent of all astronomical ideas explained by the author in his last two works, *Pancha-siddhântikâ* and *Brihajjâtaka*, as well as in certain portions of this work also. The author mentions the special characteristics of such pieces of diamonds and

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[1] Varâha goes on: "Even the Mlechchhas and Yavanas who have well-studied the science are respected as Riṣis," pp. 10-11, Translation of Mr. Chidambram Iyer, B. A., Founder of Tiravadi Jotistantra Sabha (Madura, 1884).

[2] See Iyer's Brihat Samhitâ XXXIII—XXXVI (pp. 164-174).

[3] In a sense *Brihat Samhitâ* is a socio-economic treatise dealing with the manner in which the lithosphere, hydrosphere and atmosphere of the globe affect human conditions, rather than an astronomical, geographical or botanical work. It is thus to a certain extent allied to *Arthasâstra*, and closely resembles *Yukti-kalpataru* which is perhaps based upon it.

pearls as are sacred to Indra, Yama, Viṣṇu, Varuṇa and Agni, but refers to no species as the favourites of the sun or moon, etc.

The great astronomical landmark of the 6th century, therefore, does not throw any light on any one of the several problems connected with the *Doctrine of Nine Gems*. We know only that the term *ratna* is established and that the planets influence human beings.

And this is almost where Vedic literature left us.

(*d*) *The Purâṇas.*

The evidence of Amarakoṣa, the lexicon, is not much useful. Agnipurâṇa (of the 8th century?) mentions many gems, but describes only eight: vajra, marakata, padmarâga or mâṇikya (oriental ruby), uruvinda (corundum), saugandhika (spinel), muktâ, indranîla, and vaidurrya. This list differs from that in Sukra by taking corundum and spinel, but rejecting coral, agate, topaz.

Twelve gems are enumerated in the *Garuḍapurâṇa* (9th cent.?). Nine gems are mentioned as principal in the two works that follow: (1) Agastyamatam (10th century?) and (2) Viṣṇudharmottarapurâṇa (10th cent.?). Each of these treatises enumerates more than nine gems, but the first is important as having for the first time referred to the use of nine gems[1] for the propitiation of the nine planets, and the second as having enumerated the same gems as *mahâratnas* that are mentioned by Sukra. These two works thus supply two important factors contributing to the growth of the doctrine of nine gems, that is to be found in Sukranîti, *viz.*, (1) the idea that nine gems are sacred to nine grahas, and (2) the classification or appreciation of the same gems as nine 'great jewels.'

(*e*) *Śrîpati, the astronomer.*

The idea of *navagraha* must therefore be traced to some astronomical[2] treatise between *Brihat Samhitâ* and *Agastyamatam*. That work is the *Jyotiṣaratnamâlâ* of Śrîpati, who flourished between the ages of the famous astronomers Brahmagupta (7th cent.), and Bhâskarâchâryya (11th and 12th cent.). In this treatise there is the mention of nine gems to be used in propitiating the nine planets. But Sripati's other work, *Jâtakapaddhati*, which also deals with the influences of planets on human beings mentions only seven planets.[3] In Sripati, therefore, we find both the old and the new ideas about the number and influences of planets. This self-contradiction and inconsistency are to be explained by the fact that in his time the prevalent notion about nine planets and the

[1] It gives the tests of only five gems. See the Text edited by Dr. Râmdâsa Sen. The order of consecration of gems to planets followed in this work is the same as in Sukranîti, though the interpretation of the mahâratna varies.

[2] See the Bengali work, *Astronomy and Astronomers of the Hindus*, by Prof. Yoges Chandra Ray, pp. 78-10[1] (Edition, 1903).

[3] See *Sripatipaddhati*, slokas 9, chapter III (Edition of Nirṇaya Sâgara Press, Bombay, 1903), p. 8.

[4] "Mars, the Moon and Saturn have strength by night. Jupiter, the Sun, and Venus have potency by day. Mercury is strong at all times."

utility of worshipping them especially by putting on gems was too powerful to be resisted. He had to incorporate in his second work what he had rejected as unscientific in his first.

Sripati's date[1] has not been fixed beyond doubt. He may be taken to have flourished about the 10th century, in fact, to have been almost a contemporary of the authors of Agastyamatam and Visnudharmottarapurâna. These two works as well as Jyotisaratnamâlâ were produced in an atmosphere of the same ideas regarding gems, planets and the allied topics.

Sripati's work is important from another standpoint also. The *Jyotsiaratnamâlâ* supplies the full astronomical text of the *Doctrine of Navaratna* that has been utilised in *toto* for the mineralogical section of the *Nitisâstra* of Sukrâchâryya. The same nine gems (but not called Mahâratnas) and the same system of consecration of each to the planets, the same system of nomenclature are to be found in both.[2] Thus, according to Sripati, people should put on the ruby for the sun, pearl for the moon, coral for Mars, emerald for Mercury, topaz for Jupiter, diamond for Venus, sapphire for Saturn, gomeda for Râhu, and vaiduryya for Ketu. This corresponds exactly to what Sukrâchâryya says in lines 84-92 of section ii of Chapter IV. The same system of consecration is followed in the astronomical work, Jâtaka-Pârijâta, which devotes the whole second chapter to a discussion of the nature and properties of planets.

It may be remarked here that the colour and lustre attributed to the nine planetary deities in the hymns called *Navagrahadhyâna* fit in exactly with those described in Sukranîti as pertaining to the gems. Again, the images of *Navagraha* found at Konaraka and near Bhuvaneswara in Orissa are said to belong to temples not earlier than the 10th century.[3] This is Dr. Râjendralâl Mitra's testimony in the *Antiquities of Orissa*. The hymns, the images, the temples, the astrological calculations as well as the evidences of Ratnasâstras—all point to the Doctrine of Navaratna not being older than the 10th century.

(*f*) *Subsequent Literature.*

Of the subsequent literature on the subject, *Yukti-kalpataru* is an important landmark. But though it is based on *Garuda*, *Agastya* and *Visnudharmottara*, and though it gives details relating to enumeration, characteristics and prices of the gems, it does not supply valuable information regarding the doctrine of nine gems, as it does not treat of their astral connexions at all.

So also most of the works of the 12th and 14th centuries are not important for our purposes. But *Rasaratna-samuchchaya* of the 13th-14th century,

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[1] For a discussion of dates, see Prof. Ray's *Astronomy of the Hindus*.

[2] But Sripati does not use the word *mahâratna*. Visnudharmottara uses the word *mahâratna*, but his nine mahâratnas are not the same as those of Sukra. If Sripati had taken the word *mahâratna* from *Vishnudh*, his work would have been the original prototype of *Sukranîti*. As it is, it is the earliest authority for the verse in *Rasaratna-samuchhaya* about *Navaratna*.

[3] See the chapter on *Graha* in Prof. Ray's *Astronomy of the Hindus*.

which is a very important document in the literature on metals, mentions in Chapter IV, 5, that Mâṇikya, muktâ, vidruma (*tarkṣya, i.e.*, emerald), puṣpa, vidura (diamond), nîla (sapphire), gomeda and viduraka are successively the ratnas of the nine planets. With the exception of the new terms used in this verse, *Rasaratna-samuchchaya*[1] follows exactly the system in *Sukranîti*. This work mentions other gems as well, but regards these nine as the *navaratna par excellence*. The only point in which this differs from Sukranîti is that it does not apply the term *mahâratna* to these nine gems. The work thus fully agrees with Sripati's Jyotiṣa-Ratnamâlâ (10th-11th cent.).

We now come down to *Bhâvaprakâsa* of the 16th century. This work, like the one just described, continues the full tradition originating in the astrological, religious and socio-economic literature of the 9th and 10th centuries. The *Râjanighantu*[2] of the 17th century also mentions the same nine gems as sacred to the same planets.

But the classification of *navaratnas* or nine gems into grades adopted in these two works differs from that in Sukranîti. Sukrâchâryya calls all the nine gems by the name of *mahâratnas*. But *Bhâvaprakâsa*[3] and the *Râjanighantu* mention five of them only as *mahâratnas* and call the rest *uparatnas* (inferior gems).

(*g*) *Recapitulation.*

The historical inquiry into the doctrine of nine gems leads to the following conclusions about the age of the section in *Sukranîti* dealing with gems :

1. The Sukra authors do not display astrological conceptions prior to or even contemporaneous with, those of Varâhamihira (6th cent. A.D.).

2. The doctrine embodied in Sukranîti bears the influence of the following ideas :

(i) The enumeration and appreciation of gems as nine *mahâratnas*[4] adopted by the author of *Viṣṇudharmottarapurâṇa* (10th cent.?) who quotes *Garuḍa*.

(ii) The system of consecration of the nine gems (not necessarily mahâratnas) to the nine planets followed in *Agastyamatam* (which is probably earlier than Viṣṇudharmottara, but belongs to the same age); as well as in Rasaratna-samuchchaya.

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[1] See Sanskrit Text of the work edited and published by the Anandâsram, Poona, pages 10-12.

[2] See the Hindi Edition (Benares), p. 140.

[3] See *Viswakoṣa* (Vasu's) Vol. IX, (navaratna).

[4] Nine gems are mentioned in (1) Agastya, (2) Viṣṇudharmottara, (3) Jyotiṣaratnamâlâ, (4) Sukranîti, (5) Rasaratna-samuchchaya, (6) Bhâvaprakâsa, (7) Râjanighantu.

Nine mahâratnas are mentioned only in (1) Viṣṇudharmottara and (2) Sukranîti; but the list is not the same in the two works. See the original text of Viṣṇudharmottara quoted in Dr. Sen's *Ratnarahaṣya*.

(iii) The recognition of Râhu and Ketu as the two additional Grahas who should be worshipped along with the old seven, first noticed in the second work of the astrologer, Srîpati, which, however, he had ignored in his earlier work.

3. The doctrine is certainly older than the tradition embodied in Bhâvaprakâsa and Râjanighantu (16th and 17th cent.).

4. The doctrine in all particulars cannot be traced to any work on the subject, and has not been copied in *toto* in any work that we know of. Sukranîti is *sui generis* in this respect.

The date of the second work of Sripati, *viz.*, *Jyotiṣaratnamâlâ* may thus be assigned to be the extreme upward limit of the Doctrine of *Navaratna*, as it contains the first literary evidence of *Navagraha*. This must be placed sometime in the 10th century A.D.

The mineralogical section of *Sukranîti* thus yields two furthest limits of chronology: (1) the 10th century—furnished by the doctrine of nine gems, and (2) the 14th century—furnished by the doctrine of seven metals.

There is one difficulty that remains to be explained. If the doctrine of nine planets be the basis of the doctrine of nine gems, we might expect also a doctrine of nine metals. But, though *Sukranîti* mentions altogether nine metals, it recognises only seven as principal. Or, if the doctrine of seven metals has something to do with the original seven planets, we might expect a corresponding Doctrine of Seven Gems as well. But in India the metals seem to have had no connexion with planets even up to 14th century, as has been discussed in the section on the doctrine of seven metals.

Section 11.

The Economic Mineralogy of Sukrâchâryya's India.

The Mahâratnas.

Sukrâcharyya divides the nine great gems into the following four classes in order of merit:—

(1) Vajra, being *Sreṣṭhatara*, by far the best;
(2) Good or *Sreṣṭha*: (i) Marakata, (ii) Mânikya, (iii) Muktâ;
(3) Middling or *Madhyama*: (i) Indranîla, (ii) Puṣyarâga, (iii) Vaiduryya;
(4) Inferior or *Nîcha*: (i) Gomeda, (ii) Vidruma or Pravâla.

i. Vajra or Diamond.

This gem is the favourite of the poet, *viz.*, Sukra[1] who is the preceptor of the Asuras and the author of our *Nîtisâstra*. It is very transparent and has the lustre of the star.

This is the best gem.[2] The popular notion about it is that the woman[3] who wants a son should never wear a diamond. This is perhaps one of the hard

[1] Sukra IV, ii, 89. [2] Sukra IV, ii, 98. [3] Sukra IV, 105.

substances which are to be used in cutting[1] or writing upon gems. But it is to be noted that only pearls and corals can be thus incised.

The value of this gem in terms of "money" is given below:—

(1) "The price[2] of one whole diamond weighing one *rati*, but wide in extent, is five *suvarnas* or gold coins.

(2) "The price is five times (*i.e.*, twenty-five gold coins), if it be heavier than one *rati* and superior in extent.

(3) "The price is to be less and less according as the quality falls off."

This is according to the general theory that small weight but large bulk are the conditions of the high worth of jewels. The value may be expressed in terms of *rati* in the following way: "Eight *ratis*[3] make one *mâsa*, ten *mâsas* make one *suvarṇa*." Thus 80 *ratis* make 1 gold coin; therefore 400 *ratis* make 5 gold coins. The ratio of diamond to gold, as expressed in the above extracts, would therefore be 1 to 400; or "exchange-value" of diamond is 400 times that of gold.

This general ratio is to be modified by the following considerations:

(1) Other things remaining the same, the exchange-value[4] is (*a*) one-third less than the above (which determines the 'normal' or 'natural' value), if the stone be flat-shaped, (*b*) one-half, if the stone has the colour of the reddish powder of bricks. [In the general remarks on the value of gems we noticed that this colour is not appreciated.]

(2) Other things remaining the same, the 'exchange-value' (*a*) would be half, if two pieces together[5] weigh one *rati*; (*b*) half of this (*i.e.*, one-fourth of the 'normal'), if the stones be middling or inferior.

(3) Other things remaining the same, the exchange-value of inferior or middling qualities would be determined in the following manner:[6] (*a*) By multiplying the weight in *ratis* by nine-sixteenth. (*b*) By adding together five-sixteenths and one-thirtieth.

The general rule about the determination of the 'money-value,' *i.e.*, price and 'exchange-value' of diamond is given in the following lines:

(1) The value of diamond is according to its *weight* in terms of *rati*.[7] (2) Even in the case of small pieces, the *weight*[8] has to be considered, not number (as with other gems).

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[1] Sukra IV, ii, 109-110, "The gems cannot be cut or written upon by iron or stones (diamonds) except pearls and corals." See p. 142 of my translation of *Sukraniti* in the *Sacred Books of the Hindus Series*.

[2] Sukra IV, ii, 134-137

[3] Sukra IV, ii, 138.

[4] Sukra IV, ii, 140-142.

[5] Sukra IV, ii, 142-144.

[6] Sukra IV, ii, 146-148. Specialists would do well to verify the truth and propriety of these remarks. The comparative prices given here would be discussed in the chapters on the *Data of Ancient Indian Economics* and *Public Finance*.

[7] Sukra IV, ii, 140-142.

[8] Sukra IV, ii, 168.

"In India diamonds occur over three wide areas: (1) the eastern side of the Deccan from the Penner to the Sone, (2) the Madras Presidency, especially in Kistna and Godavari basins, and (3) Chutia Nagpore and Central Provinces to Bundelkhand. It is somewhat remarkable that the Indian diamonds have not as yet been found in what can be called their original matrix. * * * None of the Indian diamond fields can, at the present day, be viewed as of commercial importance, and it is difficult, if not impossible, to identify for certain, all the localities alluded to by classical writers. * * * India was the first and for a long period the only source of diamonds known to the European nations. * * * It appears to have been worn by the nobility of India long anterior to the earliest European mention of it. * * * Tavernier was perhaps the first European who travelled over India with the express purpose of inspecting diamond mines."

The legend of the origin of *Kohinur*[1] is that it was found in the mines of the south of India, and was worn by one of the heroes of the *Mahâbhârata*, Karna, king of Anga; this would place it about 5000 years ago, or 3001 B. C. Nothing more of it is heard till it appears as the property of Vikramâditya, &c.

ii. Muktâ or Pearls

This is the favourite of the moon,[3] *i.e.*, presided over by this planetary deity, and may have red, yellow, white and syâma (swarthy or greenish blue) colour.

This gem is lower in value than diamond, but superior to the lowest, *viz.*, *gomeda* and *vidruma*, as well as to *indranîla*, *puşyarâga* and *vaidûryya*, which are middling stones. One characteristic of this jewel is that it can be written upon (like corals) by iron or stones.[4]

In the section on general remarks we noticed that gems cannot deteriorate in value except through the wickedness of kings. But pearls and corals are to be exempted from this generalisation, for they do fade through use[5] in time. The deterioration comes in naturally.

The following are the sources[6] of pearls recorded in *Sukranîti*: (1) fishes, (2) snakes, (3) conches, (4) boars, (5) bamboos, (6) clouds, (7) oyster-shells. The greatest amount is said to come from these last.

This last class of pearls is divided into three grades:[7] (1) inferior, (2) middling and (3) excellent. It is only these pearls, again *i.e.*, those derived from shells as mothers that can be pierced[8] and hence used in ornaments. Those coming from others cannot.

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[1] *Dictionary of Economic Products of India*, pp. 93-101, Vol. III (1890).

[2] See *Note on the History of the Kohinur Diamond* in *Handbook of the Manufactures and Arts of the Punjab*. By Baden Powell (1872), pp. 195-201.

[3] Sukra IV, ii, 85.

[4] Sukra IV, ii, 109-110.

[5] Sukra IV, ii, 105.

[6] Sukra IV, ii, 117-118.

[7] Sukra IV, ii, 122.

[8] Sukra IV, ii, 123. See account of pearl-boring in Baden Powell's *Punjab Manufactures*, p. 193 (1872).

And the people of Ceylon [1] can make artificial pearls like those from shells. One should therefore carefully examine pearls before purchasing them.

The test[2] is given below: "That certainly is not artificial which does not lose colour by being rubbed with *vrihi* paddy after having been soaked in hot saline water during the night. If it remains very bright it is really derived from shells. If it has middling lustre, it is otherwise."

The *Garuḍapurâṇa*[3] and *Yukti-kalpataru*[4] also describe the industry of the Ceylonese in artificial Pearl-manufacture. *Brihat Saṃhitâ*, *Garuḍapurâṇa* and *Yukti-kalpataru* mention Ceylon, Pâralaukika, Saurâstra (Guzrat), Tâmraparṇi (Malabar), Persia, Kouvera, Pândyavâtaka, and Haimadesa as the eight regions where oyster-pearls are found. According to *Agastyamatam* the places are Ceylon, Arabia, Persia, and Barbara (North Africa).

The following list of pearls is given in order of excellence,[5] the first being the best:—

(*a*) As regards layers or skins:

(1) Those with seven skins or coverings.
(2) Those with five or four skins.
(3) Those with three or two skins.

(*b*) As regards colour: (?)

(1) Red.
(2) Yellow.
(3) White.
(4) Black.

The following is the order of age,[6] the first being the oldest: (?)

(1) Yellow.
(2) Red.
(3) White.
(4) Black.

Both these lists apply only to the pearls derived from oyster-shells.

In connexion with the value of pearls the following things are to be noted:

(1) The *rati* for the measurement[7] of pearls is not the same as that for diamond and other stones. For all gems twenty *Kṣumâs* make one *rati*; but for pearls three *ratis* are made by four *Kriṣṇalas*; and twenty-four *ratis* make one *Ratnatanka*.

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[1] Sukra IV, ii, 124-125.
[2] Sukra IV, ii, 126-128. Specialists may verify it.
[3] Quoted by Prof. Yoges Chandra Ray in *Ratnaparîkṣâ*.
[4] Quoted by Dr. Râmadasa Sen in *Ratnarahasya*.
[5] Sukra IV, ii, 119-120. The correctness of the order may be tested by specialists.
[6] Sukra IV, ii, 121.
[7] Sukra IV, ii, 130-132.

Now as 4 *tankas* [1] make 1 tola of gold, 96 *ratis* (Pearl-standard) make 1 tola of gold.

(2) The exchange-value of pearls varies according as the substance is of inferior, middling, and superior grades.[2]

(3) The standard is either diamond[3] or gold.

The following are the methods prescribed for the calculation of the prices of pearls :—

(*a*) According to Diamond-standard :

(1) If the pearl is of more than a thousand *ratis* in weight, then for every hundred *ratis*, the value would be the same as of a diamond, less three hundred, divided by sixteen. (?)

(2) If the pearl is more than hundred *ratis* in weight, then from every hundred *ratis* deduct twenty *ratis*, and after such deduction the value of each *rati* would be the same as that of the diamond of the first class. Thus if the weight of pearls be 200 *ratis*, the price will be calculated after a deduction of 20 per cent. from the weight, *i.e.*, upon the weight of 160 *ratis*.

(*b*) According to the Gold-standard :

Multiply the weight[6] of the pearls in *ratis* by $13\frac{3}{4}$ and divide the product by 24, the quotient will be the value of the pearl in so many *ratis* of gold.

The following are some general remarks[7] about the worth of pearls :

(1) The best pearls are valued at half the price of gold.

(2) The best pearls are the red, yellow, round and white.

(3) The worst are the flat ones and those having the lustre of powdered bricks.

(4) The rest are middling.

"Tuticorin has been celebrated for its pearl-fishery[8] from a remote date, and as regards comparatively modern times, Friar Jordanus, a Missionary Bishop, who visited India about the year 1330, tells us that as many as 8,000 boats were then engaged in the pearl-fisheries of Tinnevelly and Ceylon."

Megasthenes' account of Indian Pearls can be gleaned from Arrian's *Indica* (VII—IX) and Pliny's *Natural History* (IX, 55). From the Bengali translation of the Greek original of Megasthenes by Prof. Guha we gather that pearl-fishery was only an application of the ordinary principles of the Fishing Industry. It was known that the oyster shells or the mothers-of-pearls lived in shoals like fishes, and resembled the community of bees with a ruling queen. If the chief

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[1] Sukra IV, ii, 138.
[2] Sukra IV, ii, 149.
[3] Sukra IV, ii, 149-151.
[4] Sukra IV, ii, 166-170.
[5] Sukra IV, ii, 152-154.
[6] Sukra IV, ii, 166-167.
[7] Sukra IV, ii, 168-170.
[8] Pearl and Chank Fisheries of the Gulf of Mannar, by Thurston, Superintendent, Madras Government Museum, p. 9.

could be caught the whole group of oysters fell an easy prey. The shells were kept in a vessel full of salts for some time until the fleshy portion decomposed of itself. The bony portion, the pearls, was then ready for use.

According to Megasthenes the value of pearls was equal to three times that of pure gold of the same weight.

iii. Mâṇikya or Ruby.

This is the sun's favourite,[1] of red colour, and has the bright lustre of *indragopa* insect. This belongs to the class of gems intermediate[2] between *vajra*, the best, and the middling ones. It is, therefore, appreciated equally with pearls and emeralds. The comparative values are not stated. We are told simply, as we have seen, that the emerald, if it is good, deserves the price of a ruby.[3] There is one more information about *mânikya, viz*, that regarding *padmarâga*,[4] which is said to be one of its varieties and has the lustre of red lotus.

"The name[5] is applied by lapidaries and jewellers to two distinct minerals—the true or oriental ruby and spinel ruby. The former may be called a red variety of corundum, is aluminic oxide. The spinel ruby is an aluminate of magnesium. * * * The ruby receives the name "oriental" from the fact of the finest red and violet varieties being obtained from Ceylon, Ava and other parts of the East."

"The delicate[6] rose pink variety of spinel, known as balas ruby, was worked for centuries in Badakshan. In the time of Marco Polo the mines were wholly in the hands of the king of Balkh.

"The chief sources, however, both of the oriental and the spinel ruby are the mines of Upper Burma. * * * The ruby mines of Burma were first made known by European travellers towards the end of the fifteenth century * * * rubies come next in value to diamonds. * * Like most other jewels, rubies have some fancied talismanic virtues attached to them. In many parts of India a bracelet formed of nine gems, of which the ruby is one, is supposed to protect the wearer from the evil eye."

iv. Pâchî, Marakata, Gârutmata or Emerald.

This is the favourite of the planetary deity Mercury.[7] It has the lustre of the feathers of the peacock or of the *châsha* (nîlakaṇṭha) bird.

This belongs to the class of pearls and *mâṇikya*,[8] *i.e.*, just inferior to the *vajra* or diamond and superior to the middling class. If the *gârutmata* is good, it deserves the price of a mâṇikya or ruby.[9]

According to *Garuḍapurâṇa* and *Agastyamatam* the source of this gem is Turkey. According to *Ratnasamgraha* it is *Mlechchhadesa*.

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[1] Sukra IV, ii, 84.
[2] Sukra IV, ii, 93-95.
[3] Sukra IV, ii, 157.
[4] Sukra IV, ii, 104
[5] Encyclopædia Britannica—Chemistry.
[6] *Dictionary of the Economic Products of India* (1892), Vol. VI, Part 1, pp. 584-589.
[7] Sukra IV, ii, 87.
[8] Sukra IV, ii, 93-95.
[9] Sukra IV, ii, 157.

v. *Indranîla or Sapphire.*

This is the Saturn's favourite,[1] is not white, but has the colour of deep clouds (blue). This belongs to the *madhyama* [2] or middling class of gems, like *puṣyarâga* and *vaiduryya*, *i.e.*, just superior to the lowest class comprising *gomeda* and *pravâla*. The value of indranîla is perhaps the same as that of gold, as can be guessed from the following: "The *puṣyarâga* weghing one *rati* deserves half the price of *indranîla*[3] or gold (of the same weight).

"It is classed [4] with 'gems or precious stones' in contradistinction to the 'inferior gems.' It is a blue transparent variety of corundum ($Al_2 O_3$) and differs from the oriental ruby merely in its colour. * * * Sapphires of various colours occur in India. * * * Sapphire is found along with many other varieties of corundum in the ruby mines of Upper Burma. * * In Ceylon * * sapphires are found frequently. In 1882 a remarkable discovery of sapphires was made in Kashmir territory."

vi. *Vaiduryya.*

Prof. Yoges Chandra Ray considers this to be chrysoberyl (oriental cat's eye), Wilson takes it for *lapis lazuli*.

This is the Ketu's favourite.[5] has the lustre of cat's eyes and has its particles moving.

Like *indranila* it belongs to the middling class of gems.[6] That piece whose three rays are coming out deserves high price.[7] Comparative values are not given.

vii Puṣyarâga or Topaz.

This is the favourite of Jupiter[8] and has the brilliancy of gold. It belongs to the middling class[9] of gems.

The piece weighing one *rati* deserves, as has been quoted above, half the price of gold or sapphire of the same weight.[10]

"It may be defined[11] as a fluosilicate of aluminia ($Al_2 O_5$ Si). * * The oriental topaz is in reality a yellow sapphire or corundum. Of the occurrence of topaz in India, Ball says, "there appears to be no authentic record, a reported discovery in the basalt of the Rajmahal hills being open to question. Ceylon, it is believed, yields a not inconsiderable proportion of the topaz of commerce."

According to *Garuḍapurâṇa* the source is Himâlaya; according to *Ratnasamgraha*, it is *Karka* and Ceylon.

viii. *Gomeda.*

It is difficult to identify it. It is agate according to Wilson,[12] but zircon according to Yoges Chandra Ray. Information about this is as meagre as about coral in *Sukraniti*.

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[1] Sukra IV, ii, 90. [2] Sukra IV, ii, 95. [3] Sukra IV, ii, 159.

[4] *Dictionary of the Economic Products of India*, pp. 474-475, Vol. VI, Part II.

[5] Sukra IV, ii, 92. [6] Sukra IV, ii, 88.

[7] Sukra IV, ii, 94. [8] Sukra IV, ii, 94.

[9] Sukra IV, ii, 160. [10] Sukra IV, ii, 159.

[11] *Dictionary of the Economic Products of India* (1893), p. 79, Vol, VI, Part IV.

[12] Wilson describes it as a stone brought from the Himalaya and the Indus, having four different colours, *e.g.*, white, pale-yellow, red and dark-blue.

It is the Râhu's favourite,[1] and like coral has yellowish red or orange colour. Like coral again it belongs to the lowest class.[2] Its value is not[3] to be determined by weight like that of all other gems. It does not deserve[4] weighing, as it is very low-priced.

The region is Himâlaya and Sindhu according to *Yukti-kalpataru.*

ix. Pravâla, Vidruma or Coral.

This is the favourite gem of Mars [5] and has yellowish red colour. Like *gomeda*, it is one of the lowest *ratnas.*

It fades through use[6] in time. Like pearls, corals can be cut or written upon[7] by iron and stones (*e.g.*, diamonds). Corals weighing one *tola* deserve half the price of the gold of the same weight.[8]

"In addition [9] to being used for adornment ornamental corals have been used in Hindu medicine from a very ancient time and are mentioned by Susruta. Ainslie remarks that the Tamil practitioners prescribe the red coral when calcined in cases of diabetes and bleeding piles."

SECTION 12.

Miscellaneous.

There are certain substances more or less allied to those dealt with in this chapter that have been referred to by the authors of the Sukra cycle in their description of the kalâs, the artisans, the industries and the Ordnance Department. These should be noted in an account of the mineralogical data available from the *Sukranîti.*

One of the general rules for the guidance of kings is that they should accumulate for future purposes such things as are useful to man. Among these are mentioned minerals,[10] implements, arms, weapons, gunpowder, vessels, etc.

1. *Sulphur.*

Sulphur[11] has been mentioned as an ingredient of gunpowder.[12] The following are the recipes for this preparation :

(1) Five *palas*[13] of *suvarchi* salt (saltpetre), one *pala* of sulphur, and one

[1] Sukra IV, ii, 91. [2] Sukra IV, ii, 129. [3] Sukra IV, ii, 86.
[4] Sukra IV, ii, 93-95. [5] Sukra IV, ii, 162. [6] Sukra IV, ii, 106, 115-116.
[7] Sukra IV, ii, 109-110. The reader is requested to note the change in the translation given here from that given on p.142 of the Vol. XIII of the *Sacred Books of the Hindus Series.*
[8] Sukra IV, ii, 161.
[9] *Dictionary of the Economic Products of India*, p. 532, Vol. II (1889).
[10] Sukra IV, ii, 60-63.
[11] The use of sulphur in medicines as copper sulphate, and iron sulphate (copperas) is as old as *Charaka Samhitâ.*
[12] Dr. Râjendralâl Mitra, who discovered the *Sukranîti* in 1875, doubts the authenticity of these lines (vide *Indo-Aryans*, Vol. I, pp. 309-12). But Dr. Gustav Oppert, who edited and published the Text for the Madras Government in 1882, proves by quotations from Vedas, Asoka's Edicts &c., that "firearms and gunpowder existed in Ancient India." See his preface to *Sukranîti* published by Madras Government, also his essays on the authenticity of Sukranîti, and *Firearms and weapons in Ancient India* published by Higginbotham & Co., Madras (1880).
[13] Sukra IV, vii, 400-404.

pala of charcoal from the wood of *arka* (Calotropis gigantea), *snuhi* (Euphorbia neriifolia) and other trees burnt in a manner that prevents the escape of smoke have to be purified, powdered, and mixed together, then dissolved in the juices of *snuhi*, *arka*, and garlic (Allium sativum), then dried up by heat, and finally powdered like sugar.

(2) Six or four parts[1] of saltpetre may also be used in the preparation of gunpowder. Sulphur and charcoal would remain the same.

(3) Experts make gunpowders in various ways[2] and of white and other colours according to the relative quantities of constituents :—Charcoal, sulphur, saltpetre, stones, *haritâl* (orpiment)[3] lead, *hingul*, iron calces (oxides), camphor, *jatu* (lac), indigo, juice of *sarala* tree (Pinus longifolia).

The use of salts, *e.g.*, Suvarchi or saltpetre,[4] has been referred to in the above recipes.

The mention of sulphur introduces us to a fact of great economic importance, and furnishes a solid basis for interpreting certain phases in the industrial history of India. "Chemical and metallurgical industries," says Mr. Holland, Director of the Geological Survey of India,

"are essentially gregarious in their habits. * * * The bye-product is a serious and indispensable item in the sources of profit, and the failure to utilise bye-products necessarily involves neglect of the minerals which will not pay to work for the metal alone."

The demand for sulphur in ancient India and the consequent supply of it in response necessarily involved, according to this 'principle of association' which is really an aspect of the Doctrine of the "Localisation[5] of Industries," a good number of auxiliary and allied industries in mining, metallurgy and manufacture, utilising the bye-products. The fact that there are no such auxiliary industries in modern India is the real explanation, according to Mr. Holland, of why a good many otherwise rich metalliferous ores cannot be worked.

We can easily turn this economic fact of modern times to account in understanding the industrial situation of the country in by-gone days. Thus we are led to infer the existence in ancient India, side by side with the sulphur industry, of all those to which it is a key. Says Mr. Holland :

"Sulphuric acid is essential for the manufacture of sulphur-phosphates, the purification of mineral oils and the production of ammonium sulphates, various acids, and a host of minor products; it is a necessary link in the chain of operations involved in the manufacture of the alkalies, with which are bound up the industries of making soap, glass,

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[1] Sukra IV, vii, 405-406.

[2] Sukra IV, vii, 411-415.

[3] "Most of the older Sanskrit MSS. are written on paper prepared with haritâla to preserve them from the ravages of insects, and this it does most effectually"—Dutt. Dr. Mitra also describes arsenicised paper in his report on Sanskrit MSS. in the proceedings of the Asiatic Society for March, 1875.

[4] This salt has been mentioned in *Charaka Samhitâ* and *Susruta Samhita* also.

[5] Illustrated in modern Europe by the contiguity of Iron and Coal Industry. "Many of the most profitable copper mines in the world could not be worked but for the demand for sulphur in sulphuric acid manufacture, and for sulphuric acid there would be no demand but for a string of other chemical industries in which it is used."

paper, oils, dyes, and colouring matters; and as a bye-product it permits the remunerative smelting of ores which it would be impossible otherwise to develop."

Industry in ancient India must therefore have been more richly diversified than at present. In fact, the extinction of several industries in modern India is explained by Mr. Holland in the following lines:

"During the last hundred years the cost of a ton of sulphuric acid in England has been reduced from £30 to under £2, and it is in consequence of the attendant revolution in the European chemical industries, aided by increased facilities for transport, that in India the manufactures of alum, copperas, blue vitriol, and alkalies have been all but exterminated; that the export trade in nitre has been reduced instead of developed; that copper and several other metals are no longer smelted; that the country is robbed every year of nearly 1,00,000 tons of phosphatic fertilisers, and that it is compelled to pay over 10 million sterling for products obtained in Europe from minerals identical with those lying idle in India." [1]

And this state will continue "until industries arise demanding a sufficient number of chemical products to complete an economic cycle."

Exactly the reverse must have been the condition of manufacture and commerce in ancient India, and for the opposite reasons.

In the Economic Volume[2] of *the Indian Empire*, also, in the *Imperial Gazetteer of India Sries*, Mr. Holland harps on this decline of ancient chemical industries:

"In this respect India of to-day stands in contrast to the India of a century ago. The European chemist, armed with the cheap supplies of sulphuric acid and alkali * * * has been enabled to stamp out, in all but remote localities, the once flourishing native manufactures of alum, the various alkaline compounds, blue vitriol, copperas, copper, lead, steel and iron, and seriously to curtail the export trade in nitre and borax. The high quality of the native-made iron, the early anticipation of the processes[3] now employed in Europe for the manufacture of high class steels and the artistic products in copper and brass gave the country a prominent position in the ancient metallurgical world, while as a chief source of nitre India held a position of peculiar political importance, until less than forty years ago, the chemical manufacturer of Europe found, among his bye-products, cheaper and more effective compounds for the manufacture of explosives."

2. *Glass.*

Râjendralâl says that the word Kâcha for glass occurs in works considerably over 2,000 years; and "seeing that the Singhalese who borrowed all the arts of civilised life from the Hindus, make mention, in the *Dipavamsa*, of a glass pinnacle, in the 2nd cent. B. C., and of a glass mirror in the 3rd cent. B. C. (Tennent's Ceylon I, 454), and Pliny describes the glass of India being superior to all others from the circumstance of its being made of pounded crystal it would not be presumptuous to believe that it was in ancient times used in India in the formation of looking glasses."

In *Indo-Aryans* Vol. I, Dr. Râjendralâl also refers to the knowledge which the Hindus had of glass as a material for the fabrication of ornaments;

[1] Review of the Mineral Production of India during the years 1898-1903 By T. H. Holland, F.R.S. (1905), see pp. 7-8, 117.

[2] Chapter III, Mines and Minerals, p. 129 (Oxford, 1907).

[3] See *Hindu Chemistry*, Vol. II., for Seal's account of Hindu achievements in chemical industry.

but from a passage in the *Yukti-kalpataru* it appears that it was also used for drinking cups or tumblers, the physiological effect of drinking water from vessels of glass being described to be similar to that of vessels made of crystal.

In *Sukraniti* Glass has been mentioned only once. The making of glass[1] vessels is a *kalâ*.

About the antiquity of glass in India, Mr. Jayaswal remarks in reviewing Dr. Schoff's *Periplus* for the *Modern Review*:

"*Glass* in India was a manufacture long before it became known to Ceylon (3rd century B.C.,) The Artha-Sâstra calls false gems "glass-gems," and mentions the manufacture of glass. Pliny's description that the glass of India was superior to all others, because it was "made of pounded crystal" and because of the discovery made by the Hindus of the art of colouring crystal, indicates a long previous history of the industry in this country. Coloured glass was well-known to the Artha-Sâstra. The glass-worker, called at present *Maniyâra*, is mentioned by the very name (Manikâra) in the Mahâvastu.

The following are the remarks of Dobbs:

"The manufacture of glass[2] was known in ancient India as early as 800 B.C., for in *Yajurveda* glass is mentioned as one of the articles of which female ornaments were made. It is also noticed in the *Mahâbhârata*, and in an old book called the *Yukti-kalpataru* that the effects on the human system of drinking water out of a glass tumbler are stated to be the same as those of drinking out of a crystal cup. In more recent times, in the 16th century, the glass of India is said to have been exported in large quantities to Europe, and in the north of Italy there is a tradition that the Venetians at one time obtained, if not their raw glass at least its ingredients, from the plains of Hindusthan."

Mr. Taw Sein-kaw also bears testimony to the antiquity of Indian pottery, both glazed and earthen, and to its having influenced the pottery and glassware of Burma.[3] "The ceramic art did not achieve any public recognition in Europe till the 16th century A. D, but long before that period the pottery of Burma had become famous." Ibn Batuta, the celebrated Arabian traveller of the 14th century, also recorded the fact.

In Yub's *Hobson-Jobsan* we have the following:—

"In this town of Martaban (now a small village in Amherst district) are made very large and beautiful porcelain vases, and some of glazed earthenware of a black colour, which are highly valued among the Moors, and they export them as merchandise."

And Mr. Seinkaw observes that Taikkalâ, one of the most important seaports of the country governed by the rulers of Martaban:

"was colonised, (as the name implies), by the Gaudas of the ancient city of Gour in Bengal. On the site of this historic Taikkalâ, traces of a wall and moat still exist, and fragments of pottery and glazed tiles are found."

3. *Alkalies.*

Alkalies also have been mentioned in *Sukraniti* as *Kṣâras*. Thus one of the 64[4] arts or *kalâs* is the extraction or preparation of alkalies. Government

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[1] Sukra IV, iii, 191.

[2] See *Monograph on the Pottery and Glass Industries of the North-Western Provinces and Oudh* by Dobbs (1895, Chapter IX, p. 29).

[3] *Monograph on the Pottery and Glass ware of Burma* (1894-95), pp. 2-3.

[4] Sukra IV, iii, 150.

revenue from this chemical industry is declared to be one-half[1] of the produce after the costs have been met.

4. *Stones.*

Stones have been referred to several times. We have just seen that these may be used as ingredients for gunpowder. Their use in statuary, iconography, and sculpture has been mentioned by the Sukra authors in their description of the images of gods. We have already alluded to this in connexion with metals.

We are told that stones are next in importance to metals in the construction of images in point of durability,[2] and superior to all other materials, *e.g.*, sands, pastes, paints, enamels, earth, wood, &c. The responsiblity of the sculptor, therefore, is very great. For he must have to be well up in the conventions of the art. His workmanship would not be appreciated unless it conforms to the exact rules laid down by the masters of *Silpasâstras.*

The images that are made of less durable material are not examined by people very critically, and hence may be executed without particular care. But stone being a durable material involves on the artist an extra amount of carefulness.

But such stones as are found in hills and rivers may be used for religious purposes without human art being made to work upon them. Defects of[3] measurement are not to be noticed in such images, *e.g.*, the natural *Vânalingas* of the *Narmadâ* valley, Chandrakânta gems, or stones found in the Gandaka river.

When stone images are constructed the worshippers should observe a rule with regard to the colour of the material used. "The white stone[4] is prescribed for the Satyayuga as indicating *sâttwika* type of images, the yellow and red stones are prescribed for Tretâyuga and Dwâparayuga respectively as indicating *râjasika* type, and the black stones for the Kaliyuga as indicating *tâmasika* type. These types of images will be discussed in a subsequent chapter.

Image worship being a universal feature of Indian religious life, the industry connected with stones must be expected to have been a very rich one in the days of Sukra authors, as in all ages in Indian history. Not in religious life only, but in other departments of the social life of the people also, stone-quarrying, stone-carving, stone-inlaying as well as other industries and fine arts connected with the manipulation of sandstones, building stone, granite and marble, have played a conspicuous part. Hence in *Sukranîti* we find that among the sixty-four *kalâs* there is one connected with stones.[5]

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[1] Sukra IV, ii, 283-85.
[2] Sukra IV, iv, 150-151.
[3] Sukra IV, iv, 305-308.
[4] Sukra IV, iv, 310-313.
[5] Sukra IV, iii, 167-168.

This consists in the art of cleansing, polishing, dyeing, rinsing, &c., of stone vessels. There is another art also mentioned by Sukrâchâryya as being an auxiliary of Ayurveda. This is the melting and incineration of stones.[1]

Again, stone-carvers[2] are sufficiently important to be recognised by the statesmen of the Sukra cycle in their enumeration of the artists and artisans whom the state should " protect " by finding suitable employment.

It is stated by Fergusson that there is no stone architecture in India earlier than the 3rd century B.C. But says Mr. Crosthwaite :[3]

" The negative fact that no stone architecture previous to Aśoka has yet been discovered, does not justify the positive conclusion arrived at by Fergusson. * * * The famous Sâranâth stupa and the stupa near Kasia in Gorakhpur are even older than the 3rd century B.C. The excavation of a stupa at Piprahwa in Basti District yielded a casket bearing an inscription in the character of the 3rd or 4th century B.C. * * * The stone mason's art must have existed in India for some centuries before Aśoka's reign. "

The following refers to Southern India :

" Early stone-carving reached a high degree of perfection, first under the Buddhists in India and even sometime before it,[4] * * * following the Buddhists each successive Hindu dynasty left examples of their particular styles. * * * Towards the end of the Hindu period the Vijayanagara kings were the greatest patrons of stone-carving.

" The perfection [5] to which the art of stone-carving was carried and the proportions attained by the industry can be readily, if roughly, gauged by the extent of the architectural remains still in existence, and the profusion and finish of the ornamental work with which they are enriched. The proportion which the decorative industry bore to the constructive defies accurate computation, but judged by European standards it must have been extraordinarily high. "

Mr. Vincent Smith[6] testifies to the skill of Hindu lapidaries :

" Hindus, as Mr. King observes, were among the earliest of mankind to attain to mechanical perfection and facility in the treatment of the hardest stones, executing with facility many operations which would baffle the skill of the most expert modern lapidary; such as boring fine holes with the greatest precision, not merely through the sardonyx, but even through the sapphire and the ruby. All considerable collections of Indian antiquities comprise numerous specimens of pierced beads made of various precious and semi-precious stones, which display the complete mastery of the old craftsmen over the most different material."

Regarding the use of stones in the manufacture of sofas, chairs, benches, etc., in Hindu India, the following is quoted from *Indo-Aryans* :[7] " Of stones, the gritty sandstone alone was condemned, and the other kinds recommended, with the proviso that the colour of the stone should correspond with that of the planet which presided for the time being on the destiny of the person who

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[1] Sukra IV, iii, 145.

[2] Sukra II, 397-398.

[3] Monograph on Stone Carving (1906).

[4] *Monograph on Stone-carving and Inlaying in Southern India* by Rea (1906).

[5] *Stone-carving and Inlaying in the Bombay Presidency* by Tupper (1906).

[6] History of Fine Art, p. 355.

[7] Sukra I, 252-53.

was to use the seat; thus when a man happened to be under the influence of Saturn, he had to use a stone seat of a blue colour, but if Venus happened to be the presiding planet, a bright yellow stone was the most appropriate."

Regarding evidences for the treatment of stones in Hindu Architecture and Sculpture, besides the works of the historians of Indian Art, previously referred to several times, some of the unpublished collections of private associations in Bengal deserve a special mention. Such literary bodies are the Bangîya Sâhitya Parişat of Calcutta, Rangpur Sâhitya Parişat, Dacca Sâhitya Parişat, etc., and District Council of National Education, Malda, whose collections[1] of Gauḍa and Pandua relics were exhibited by the distinguished antiquarian, Râdhes Chandra Seth, at a conference of the men of letters belonging to North Bengal. But the most considerable are the recent finds of the Varendra Research Society in Râjsâhi. All these stones have opened up a new field for students of Indian art-culture and archæology.

The explorations of this last academy have presented us with some of the most exquisite specimens of stone images of various Buddhistic and Hindu gods and goddesses of the Tantric type, which should have a place in the sculpture-gallery of the nation, as embodying probably the ideals of an yet unstudied School of Hindu Art. We have also inscribed stone-pillars and monuments which reveal altogether unknown facts of the political, economic, and commercial history of Eastern India in mediæval times (8th—13th cent). To quote Mr. Akşaya Kumâr Maitra, the guide and philosopher of the Varendra school of historical research: "These and similar inscriptions show at a glance of what stuff were made the people of old Bengal, who at one time extended their empire from shore to shore, between the Himalayas on the North and the Vindhya on the South, and what constituted the high education of the people of that age." Further, "although the Pâla kings were Buddhists, their hereditary ministers were all Brahmans. * * * Bhatta Gurava, the builder of this monument, was not only a pious Brahman, but was also an efficient minister of state, a valiant warrior, and a poet who used to be looked upon by his contemporaries as a Vâlmîki of the *Kalikâla*."

The most important stone pillars brought to prominent notice by this school of historians are (1) the inscribed *Garuḍastambha* pillar (in Dinâjpur), (2) the inscribed pillar of the Kâmboja king—a carved pillar of black basalt (in Dinâjpur), (3) the pillar of the Kaivarta leader—a stone monolith "which may be looked upon as a finger-post to indicate the decline and fall" of the Pâla Empire.

Stone-images of Viṣṇu, Durgâ, Sun-god, Bodhisattva, etc., found by the Varendra Research Society, as well as other materials in their possession enable Mr. Maitra to make the following remarks with regard to what may be proved to be the site of the capital of an old prosperous empire in the

[1] See the full report of the Malda Conference (1911) published in Bengali (1913) by the *Sâhitya Parişat* of Rangpur.

modern district of Malda, lying north to south on the east of the river Mahânandâ: "It was indeed a city of palaces,[1] a city of gardens, and a city of fine tanks. * * * These suburban areas (including modern Pandua, Kaligrâma,[2] and other modern villages) enjoyed for a long time a great reputation as an important centre of the old weaving industry of Bengal. * * * Towards the south of the great city, there was another suburb, modern Mâdhâipur, still remembered as one of the traditional centres of Sanskrit education in the Empire of Gauḍa under the Hindus, before Nadia asserted its influence. * * * Old Malda was the port of the city connected with the Far East as well as with the historic markets of the western world."

[1] See *Stones of Vârendra*—in the *Modern Review*, June, August and September 1912.

[2] An important Tantric image of the goddess, popularly called Bhairavi, in the vicinity of Kaligrâma, has been brought to the notice of the literary world by Mr. Haridâsa Pâlit, of the District Council of National Education, Malda, and described with illustration in the Bengali monthly, the *Grihastha*, Calcutta.

CHAPTER V.

THE DATA OF ANCIENT INDIAN BOTANY.

SECTION 1.

Sukraniti an a source of Botanical Information.

In *Sukranîti* references to plants and plant-life fall into three classes:

1. The *Nîtisâstra* being the architectonic or dominant science, whatever has any influence on human and social life must be discussed in it. Treatment of botanical topics thus has a very natural place in *Sukranîti*. In Hindu literature there is the tradition of Varâhamihira, the scientist of the 6th century A.D., having treated of more than a thousand phenomena of Nature as affecting the well-being of humanity in his celebrated treatise, *Brihat Samhitâ*.

2. The flora of a locality as well as the Botanical ideas obtaining in any epoch cannot but leave their mark on the literary activities of a people. The casual references of authors to vegetation, the features or habits of plants, and their uses in social life are some of the internal evidences which may be interpreted as telling the story of the author's range of experiences. Like the Data of ancient Indian Mineralogy and Geography, the Data of ancient Indian Botany that may be culled from a study of the flora in Sukranîti would thus furnish important clues to the home and surroundings as well as the epoch in which the authors of the Sukra cycle flourished. For in the first place, types of flora vary from province to province, and secondly, the knowledge about plant-life changes from epoch to epoch. The Botanical references in Sukranîti, therefore, must carry with them the 'spirit' of both Space and Time.

3. The authors of the Sukra cycle have not treated of plants *as plants*, but as substances having a direct or indirect bearing on the social, economic and political topics that concern them mainly. The treatment of plants in *Sukranîti* is, therefore, not at all what should be expected in Botany as an *abstract science*, but is purely *utilitarian* or economic. The Economic Botany of Sukrâchâryya, again, eschews the medical or Ayurvedic, and industrial or artistic branches, but is treated of only in the following aspects: (1) Agriculture, (2) Horticulture and (3) Forestry.

SECTION 2.

Identification of the Sukra Flora.

The trees, plants, shrubs, creepers, &c., mentioned in Sukranîti are being shown in three schedules.[1] The first schedule contains the plants grouped together by the authors of the Sukra cycle under the common name of *Phalinah* or fruit-bearing. The second schedule contains the plants grouped

[1] See the lists in Meyen's *Botanical Geography* (Ray Society, London, 1846), pp. 390-395.

together in the treatise under the common name of *Kantakinah* (thorny) and *Âraṇyaka* (growing in forests).

The classification is not at all scientific according to the principles of modern Botany, nor does it indicate any cleverness from the ordinary standpoint of the layman. For even as yielding edible fruits some of the plants mentioned in the second list might be well-placed in the first.

The third schedule contains the trees, plants, or shrubs to which only casual references have been made.

(*a*) *The Phalinah or Fruit-bearing Trees.*[1]

It is to be noted that the term fruit-bearing has not been used in the strict Botanical sense of Phanerogams, which, being flowering plants, are necessarily also fruit-bearing. The Sukra authors mean simply that these trees grow fruits either in abundance or such as are appreciated by men as edibles or articles of commerce.

	Sanskrit name.	English name.	Botanical name.	Habitat.
1.	Udumvara ...	...	*Ficus glomerata* ...	Sub-himalayan tract and outer valleys, in ravines, on the banks of rivers and in damp places, Ajmere-Merwara, Aboo, Behar, Chutia Nagpur, Bengal plains, Khasi Hills, Chittagong, Lower Burma, Irrawadi valley, Western Peninsula, Central Provinces.
2.	Aśwattha ...	Holy fig-tree (Peepul).	*Ficus religiosa* ...	Indigenous in the Sub-himalyan tract. Cultivated throughout India. Rare in the arid regions of N. W. India. Common on and destructive to buildings in Bengal. Sacred to Hindus and Buddhists.
3.	Vata ...	Banyan ...	*Ficus bengalensis*	Commonly planted by the Hindus throughout India as far north as Peshawar and in the outer Himalaya as high as 4,000 feet.
4.	Chinchâ ...	Tamarind ...	*Tamarindus indica*	Cultivated throughout India and Burma. Self-sown in waste and forest lands. The fruit does not ripen west of Amballa.
5.	Chandana ...	Sandal ...	*Santalum album* ...	Indigenous in W. Peninsula. Grown in gardens north as far as Saharanpur.
6.	Jâmbhâla ...	Lime—acid and sweet, citron, lemon.	*Citrus medica* ...	Kumaon, C. P., Sikkim, Garo Hills, Satpura Hills, Western Ghats, Chittagong, Khasi Hills.

[1] See Botanical Volume of the *Bombay Gazetteer* (1886), *Indian Trees* by Brandis, *Indigenous Drugs of India* by Kanny Lall Dey and *Dictionary of Economic Products* by Watt.

	Sanskrit name.	English name.	Botanical name.	Habitat.
7.	Kadamba ...	...	*Nauclea cadamba* ...	Terai and outer hills of Sikkim to 3,000 feet, evergreen forests of North Kanara, Northern Circars, Cuddapah and Karnul, Eastern slopes of the Pegu Yoma. Commonly planted.
8.	Aśoka ...	...	*Jonesia asoka* ...	Khasi Hills, Arakan, Tenasserim, Western Peninsula, Northern Circars, and in evergreen forests of the Kankan and Kanara. Frequently planted, chiefly near temples in India and Burma.
9.	Vakula ...	...	*Mimusops elengi* ...	Western Peninsula, southwards from Kandala Ghat on the west and Northern Circars on the east. Commonly planted, north as far as Lahore.
10.	Vilwa ...	Bael tree ...	*Ægle marmelos* ...	Wild in the Sub-himalayan tracts and outer hills from the Jhelum eastwards, also in S. India and Burma. Cultivated throughout India on account of its fruit.
11.	Amrita ...	Pear tree (Nâṣpâti in Hindi).	*Pyrus communis*	Largely cultivated in N. W. Himalaya.
12.	Kapitthaka (Kât bel in Hindi).	Wood-apple ...	*Feronia elephantum*	Generally cultivated in both peninsulas. Indigenous in S. India and Ceylon. Bark used as a cosmetic.
13.	Râjadana ...	...	*Mimusops hexandra*	Banda District, sandstone of Pachmarhi and adjoining hill ranges, Chanda District, Gujrat, Khandesh, Deccan, Srihari Kota.
14.	Âmra ...	Mango ...	*Mangifera Indica*...	Indigenous in Burma, Sikkim, Assam, Khasi Hills, Satpuras, W. Ghats. Cultivated all over India and Burma, excepting the northern part of the Punjab.
15.	Punnâga ...	...	*Calophyllum inophyllum.*	On the west coast from Bombay, on the east coast from Orissa southwards. Often cultivated, Saline tracts, Minbu District, Upper Burma.
16.	Kâṣṭhâmra ...	...	*Myrica sapida* ...	Outer Himalaya from the Ravi eastwards,

	Sanskrit name.	English name.	Botanical name.	Habitat.
17.	Tuda ...	Mulberry ...	(1) *Morus alba* ...	(1) Punjab plains, Kashmir, N. W. Himalaya.
			(2) *Morus indica* ...	(2) Wild in the Sub-himalayan tract in dry forest from the Sutlej eastward. Extensively cultivated to feed the seedworm in Bengal and Burma.
18.	Champaka ...	...	*Michelia champaka*,	Wild on the Western Ghats in the southern portion, in Sikkim (up to 3,000 feet) and in Lower Burma. Cultivated in the moister parts of India and Burma, shady valleys in Singhbhum.
19.	Nîpa ...	...	Variety of *Jonesia asoka*.	
20.	Koka ...	Wild date tree	*Phœnix sylvestris*	Indigenous and gregarious in many parts of India. Planted largely. Mats and baskets made of leaves. Sugary juice extracted in the cold season.
21.	Âmra ...	...	*Spondias mangifera*.	Sub-himalayan tract and outer valleys to 3,000 feet from the Chenab eastwards. Salt range in the Punjab, deciduous forests of Burma and the Western Peninsula.
22.	Sarala ...	Pine ...	*Pinus longifolia* ...	Sub-himalayan tract and outer Himalaya, abundant as far east as Nepal ; not in the inner arid valleys. Further eastward less common, in Sikkim usually on dry southern slopes. It is supposed that the rainfall in the Sub-himalayan tract here is too heavy for this species (Gamble's *Darjeeling List* Ed. ii. 1888).
23.	Dârima ...	Pomegranate ...	*Punica granatum*	Indigenous in Persia and Afghanistan. Cultivated. Naturalised in India from remote antiquity.
24.	Akṣota ...	(1) Walnut (ákhrot in Hindi).	(1) *Juglans regia* ...	(1) Indigenous trans-Indus in the Kurram valley, N.-W. Himalaya, Sikkim.
		(2) Indian walnut.	(2) *Aleurites moluccana*.	(2) Indigenous probably in the Malaya Archipelago. Cultivated in most tropical and subtropical countries, and here and there naturalised.

	Sanskrit name.	English name.	Botanical name.	Habitat.
25.	Śiṃśupâ ...	...	*Dalbergia sissoo* ...	Sub-himalayan tract and in outer valleys from the Indus to Assam. Extending far into the plains along river banks. Planted and often selfsown throughout India.
26.	Bhissata.			
27.	Vadara ...	Jujube (kool in Bengali).	*Zizyphus jujuba* ...	Indigenous and naturalised throughout India and Burma. Grown in gardens for its fruit.
28.	Nimba ...	Neem or Margoza.	*Azadirachta indica*	Wild in the dry region of the Irrawady valley. Cultivated and naturalised throughout India, rare west of the Sutlej.
29.	Śimbhu.			
30.	Jambîra ...	Lime ...	Variety of *Citrus medica.*	
31.	Kṣirika ...	...	Variety of *Mimusops hexandra.*	
32.	Kharjura ...	...	(1) Variety of *Phœnix sylvestris.*	
		(2) Date-palm	(2) *Phœnix dactylifera.*	(2) Cultivated and selfsown in Sind and Southern Punjab, attempts to grow it have been made in other parts of India.
33.	Deva karaja ...	...	*Pongamia glabra* ...	Common near banks of streams and water-courses in both peninsulas. Travancore, Oudh Forests, here and there in Subhimalayan tract, ascending to 2,000 feet.
34.	Phâlgu ...	Opposite-leaved fig tree. (?)		
35.	Tâpinchchha[1] (Tamâla).	...	Variety of *Garcinia xanthochymus.*	
36.	Simbhala.			
37.	Kuddâla ...	Ebony ...	*Diospyros melanxylon.*	Common in deciduous forests of C. P., Chutia Nagpur, Behar and W. Peninsula.
38.	Lavalî ...	...	(1) *Phyllanthus distichas.*	(1) In gardens throughout India.
			(2) *Anona reticulata*	(2) Cultivated over a great part of India.

[1] It is to be noted that *Tâpinchchha* is a variety of *Tamâla* (Garcinia xanthochymus) included in the list of wild flora in *Sukranîti.*

	Sanskrit name.	English name.	Botanical name.	Habitat.
39.	Dhâtrî ...	...	*Woodfordia floribunda.*	Widely spread from tropical Africa, Arabia to India, ascending to 5,000 feet in the Himalaya and to both peninsulas.
40.	Kramuka ...	Betel-nut ...	*Areca catechu* ...	Cultivated in the tropical and sub-tropical regions of India and Burma, in gardens and orchards on the W. coast and in N. Bengal. The seeds are an important article of trade, the spathes are used to write upon, to wrap up parcels, and as covering leaf of cheroots in Burma.
41.	Mâtulungaka...	Citron ...	Variety of *Citrus medica.*	
42.	Lakoocha ...	...	*Artocarpus lakoocha.*	Sub-himalayan tract and outer hills, from Kumaon eastwards, ascending to 4,000 feet Khasi Hills. Burma, evergreen forest of the Western Ghats from the Konkan southwards.
43.	Nârikela ...	Cocoanut ...	*Cocos nucifera* ...	Cultivated throughout the tropics, chiefly in the vicinity of the sea, but also inland.
44.	Rambhâ ...	Plantains ...	*Musa sapientum*...	Extensively cultivated throughout India, nearer coast tracts than inland.

The list of fruit-bearing trees in the Sukra Flora contains 44 plants. Of these four have not been identified, *viz.*, (1) Bhissata, (2) Śimbhu, (3) Simbhala and (4) Phâlgu. The remaining 40 plants belong to 35 species, as four species have been mentioned in varieties comprising nine plants, *e.g.*, (1) *Citrus medica* as Jambhâla, Jambîra, and Mâtulungaka, (2) *Jonesia asoka* as Asoka and Nîpa, (3) *Mimusops hexandra* as Râjadana and Kṣirika, (4) *Phœnix sylvestris* as Koka and Kharjura.

These 35 species are grouped under the following 19 Natural Orders :—

I. Rutaceæ ...	...	(1) Citrus medica.
		(2) Ægle marmelos.
		(3) Feronia elephantum.
II. Urticaceæ ...	...	(1) Ficus glomerata.
		(2) Ficus religiosa.
		(3) Ficus bengalensis.
		(4) Morus alba or Indica.
		(5) Artocarpus lakoochu.
III. Leguminosæ ...	...	(1) Tamarindus indica.
		(2) Jonesia asoka.
		(3) Dalbergia sissoo.
		(4) Pongamia glabra.

IV.	Santalaceæ	...	Santalum album.
V.	Rubiaceæ	...	Nauclea cadamba.
VI.	Sapotaceæ	(1)	Mimusops elengi.
		(2)	Mimusops hexandra.
VII.	Rosaceæ	...	Pyrus communis.
VIII.	Anacardiaceæ ...	(1)	Mangifera indica.
		(2)	Spondias mangifera.
IX.	Magnoliaceæ	...	Michelia champaka.
X.	Palmaceæ	(1)	Phœnix sylvestris.
		(2)	Areca catechu.
		(3)	Cocos nucifera.
XI.	Coniferæ	...	Pinus longifolia.
XII.	Juglandaceæ	...	Juglans regia.
XIII.	Meliaceæ	...	Azadirachta indica.
XIV.	Euphorbiaceæ... ...	...	Phyllanthus distichas.
XV.	Musaceæ	...	Musa sapientum.
XVI.	Guttiferæ	(1)	Calophyllum inophyllum.
		(2)	Garcinia xanthochymus.
XVII.	Myricaceæ	...	Myrica sapida.
XVIII.	Ebenaceæ	...	Diospyros melanxylon.
XIX.	Lythraceæ	(1)	Woodfordia floribunda.
		(2)	Punica granatum.

(*b*) *The Âraṇyaka Trees.*

The following list contains the names of trees which, according to Sukrâchâryya should be planted in forests :—

Sanskrit name.	English name.	Botanical name.	Habitat.
1. Khadira ...	Catechu ...	*Acacia catechu* ...	Sub-himalayan tract from the Indus eastwards, generally gregarious on islands and on the banks of rivers at their entrance into the plains. Common on the Aravalli Hills and in the W. Peninsula, as well as Burma, Central Provinces, Chutia Nagpur, Behar.
2. Asmanta ...	Oxalis, (?) probably Indian hemp.	*Crotalaria burhia*	Common in the plains of Sind, Punjab, W. Rajputana and Gujarat.
3. Śâka ...	Teak ...	*Tectona grandis* ...	Indigenous in both peninsulas. In W. India attains its northern limit in W. Aravallis at 24°42′ N. Lat. In C. India its northernmost point is Jhansi. Cultivated in Bengal and Assam and in N. India as far as Dehra Dun.

Sanskrit name.	English name.	Botanical name.	Habitat.
4. Agnimantha ..	...	*Premna integrifolia.*	West Peninsula, Bengal, Burma.
5. Syaunáka ...	...	*Oroxylum indicum*	Sub-himalayan tract from the Jumna eastwards. Rare west of the Jumna.
6. Vabbula ...	...	*Acacia arabica* ...	Indigenous in Sind and Northern Deccan, including Berar and Khandesh. Cultivated and naturalised throughout India, except in the most humid regions. The pods are excellent cattle-fodder. Gum exudes largely from wounds in the bark.
7. Tamála ...	...	*Garcinia xanthochymus or Cinnamonum tamála.*	Sikkim, Assam, Khasi, Chittagong, W. Peninsula, Circars, W. Ghats, N. Kanara.
8. Sâla ...	...	*Shorea robusta* ...	Two irregular, but fairly defined belts: (1) Sub-himalayan belt from Kangra valley to Darrang (Assam). Further to N. W. the cold is too severe, further east, the climate is too moist. (2) Central Indian belt extends from Coromandel coast west to Pachmarhi sandstone hills and south to Godavari river.
9. Kutaja ...	...	*Holarrhena antidysenterica.*	Sub-himalayan tract, from the Chenab eastwards, common in sâl forest. Aravalli Hills, Behar, C. P. western Peninsula, Bengal. One of the trees to be employed in reclaiming waste lands.
10. Dhava ...	...	*Anogeissus latifolia*	Sub-himalayan tract from the Ravi to Nepal, C. I., Western Peninsula, Chutia Nagpur, Behar, Orissa. Not in Assam, Eastern Bengal nor Burma.
11. Arjuna ...	...	*Terminalia arjuna*	Common on the banks of rivers, streams and dry water courses in C. I. and S. Behar, in the Peninsula and Ceylon, Jammu, Chutia Nagpur. Here and there in Sub-himalayan tract. Not in east and Central Bengal, nor in Burma.
12. Palâsa .	...	*Butea frondosa* ...	Common throughout India and Burma, often gregarious. In the N. W. Himalaya. In Travancore not common.

	Sanskrit name.	English name.	Botanical name.	Habitat.
13.	Saptaparṇa ...	...	*Alstonia scholaris*	Sub-himalayan tract, ascending to 3,000 feet from the Jumna eastwards. Western Peninsula and Burma, mostly in deciduous forests, Bengal, Assam, Andamans.
14.	Śamî ...	...	*Acacia suma* ...	W. Peninsula, both on the west as well as east side extending north to Pertabgarh, in S. Râjputana, Lower Bengal.
15.	Tunna ...	...	*Cedrela toona* ...	Sub-himalayan tract from the Indus eastwards. Evergreen forests of the W. Ghats and other hills of the W. Peninsula, Khasi Hills, Manipur, Upper and Lower Burma. Cultivated extensively.
16.	Devadâru ...	Himalayan cedar.	*Cedrus deodara* ...	Afghanistan, Chittral, Kurram, N. W. Himalaya. On two feeders of Alakananda. Cultivated in Kumaon and Nepal.
17.	Vikankata ...	...	*Flacourtia sapida*	Sub-himalayan tract from the Punjab eastwards, Rajputana, Behar, Central India, the Deccan, and the Peninsula, mostly in dry open places and on rocky hills, Manipur.
18.	Karamarda ...	...	*Carissa carandas*	Cultivated for its fruit in most parts of India.
19.	Ingudî ...	...	*Balanites roxburghii.*	Chiefly in the drier parts of India and Burma, as far north as Delhi, common in the open country, particularly on stiff clay soil.
20.	Bhûrja ...	...	*Betula bhojaputra*	Kurram valley, 10—11,000 feet, in Himalaya, 10—14,000 feet, in the Punjab as low as 7,800 feet, also in the inner arid region. Often gregarious at the upper limit of tree vegetation. The outer bark is used as a paper for writing and packing, for umbrella covers and for the roofing of houses.