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Editorial

Trade-links, Commerce and Exchanges of Scientific Ideas in Antiquity

The Present issue (*IJHS*, 51.4) is the outcome of the papers presented at the Seminar on Cross Civilizational Interactions in Antiquity — India, Iran, Greece and China. It was organized on 7-9 January 2015 in several venues in New Delhi including INSA under the over-all guidance of Drs Lotika Varadarajan and Surajit Sarkar of the Ambedkar University, Delhi. The papers have been duly processed as per resolutions and norms of *IJHS*. The main objective of the seminar was to appreciate the role of trades & commerce, and focus on common links, exchanges, similarities of ideas & knowledge, product & processes, arts and crafts among the cultures in antiquity— Iranian, Greek, Indian and Chinese following Achaemenid empire in the sixth century BCE. A similar pattern of prehistoric art and culture throughout Asia, from Mediterranean to Hoan-ho river and Indus, might have prompted this idea since there were regular movement of peoples, and some form of trades and commerce known from prehistoric times.

The Achaemenid (c. 550 BCE–330 BCE), also called Persian empire in Iran, flourished during its powerful period extending its campaign from the shores of Mediterranean penetrating to Taxila, Gandhāra and the banks of Indus and including parts of Punjab as one of its satraps. By 5th century BCE, India, Afganistan, Bactria, Iran, western Asia and parts of Central Asia formed more or less one political unit in spite of mountain barriers. Indian troops formed light divisions under Persian armies and the Ionian officers in Persian employ fought many a battles, and there are reports that Ionian traders visited India. Ctesias, a Greek physician in the Persian court composed a book, *Indica*, narrating fantastic stories about India, which might have exerted great influence upon Greek perception of India. After Alexander's invasion of India in 326 BCE and subsequent development of the Bactrian Greek kingdom further deepened, and survived as a bridge between India and west Asia. Greco-Bactrian kings in the north-western India exerted considerable political influence by establishing profitable trade relations with Alexandria, Red Sea ports with the help of Ptolemy Philadelplus (285-246 BCE) and that of Roman emperors Augustus (27 BCE -14 CE) to Marcus Aurelius (161-180 CE). Towards the end of first century BCE a new chapter in Indo- Roman trade relations was ushered. The Kuṣāṇas established authority from borders of the Caspian Sea to the mouth of the Ganges ruling over Bactria, Arachosia, Kaofu, Gandhāra and the whole of north India encouraging trade and commerce. This was again the period of Buddhism and along with Buddhism, Indian thoughts & practices, language and literature in *Kharoṣṭi* and *Brāhmi* scripts invariably spread over a vast area

Sea-routes over several Harappan and post-Harappan ports at Barygaza (Modern Broach), Awra, Lakhabawal, Prabhāsa (Somnath) and Megham including Lothal in the western coast of India were still active. As regards Sea-ports and commerce, Kauṭilīya *Arthśāstra* reports that the Superintendent strictly enforced the rules framed by the management of ports. He was also empowered to destroy pirates and punish those who did not follow the rules. Distinguished merchants and foreign travellers were received by him with due courtesy. The influence of Buddhism under Aśoka's missionary activities travelled far to the west including Greek dynasties of Bactria. This is well attested in *Millinda Panho* (2nd century BCE), which clearly establishes the increasing hold of Buddhist thought over Indo-Greek monarchies. Panikar, K.M. (1962) gives also an idea of the Maritime activities of south India with the countries of Middle East of the time which existed between the ports of the Persian Gulf, the Red Sea and the west coast of India.

Overland trade – routes, despite formidable mountain barriers and dangers, north-west India, Afganistan, Iran, western Asia and parts of central Asia formed almost one political unit under the Achaemenid empire as far as trade in India and outside India is concerned . The names of important routes are known from the publications of scholars like, Prasad, P. C. (1977), Moti Chandra (1977), Sen, S. N. (1985), a summary of which will be of interest:

***Uttarāpatha* (as referred to by Pāṇini & others)**: Manipur (Assam) → Mahāsthāna → Gauḍa → Pundravardhan → Bhukti → Vaiśāli → Kuśinagar → Kapilāvastu → Śrāvasti → Ahikṣetra → Indraprastha → Taxila→ Puskalāvati or Puruṣapura (Capital of Gandhāra; *Po-lu-sha-pu-lo* of Hsuan-Tsang or modern Peshawar of ai-Biruni). Taxila and Puruṣapura were on either side of the Indus. Puruṣapura was also connected via Gauḍa to Tāmralipta on the Bay of Bengal by overland routes; Another route: Gayā → Kāśi → Prayāga → Kanauja →Śankāśya → Soron → Indraprastha;

Indraprastha – Broach: Indraprastha → Mathura → Ujjain (Ozene of the Greeks) → Minnagara → Broach (Barygaza);

Śrinagar – Turkistan: Śrinagar (Kashmir valley) → Gilgit → Yarkand → Kashgar → Parts eastern and western Turkistan;

Puruṣapura-Bactria: Puruṣapura → Kapiśa → Bamban → Bactria; Kapiśa & Hsuan were great Buddhist centres; Hsuan Tsang went to Bactria from Samarkand by crossing the Oxus (easily navigable according to Strabo), and following a route through Bamyan, Kapiśa reached Gandhāra;

Bactria – Antioch: Bactria → Merv → Ecbatana → Selucia Ctesiphon → Anioch (Highway);

Bactria – Caspian: Strabo, Pliny and other ancient geographers have referred to this route favoured by Indian traders to send their merchandise to Caspian sea ports.

Silk Routes: Kashgar → Samarqand → Bukhara; Kashgar → Kuchi → Karashahr → Turfan (via north of Tarim Basin) → Tunhuang; Kashgar → Khotan (south of Tarim Basin) → Niya → Charkliq → Tunhuang; Kashgar and Samarqand were on the junction of the main trade route from India (via Balkh), from Persia (via Merv) and from Turkish dominions.

Route to China: Through Kashgar and Tarim Basin;

Scripts and language were also the vehicles of communication of the time. Aśoka (c.250-232 BCE), the Maurya emperor in the north-central India, has left behind some inscriptions both in Brāhmi and Kharoṣṭi (called Edicts) both being alphabetic system of writings. **Brāhmi** inscriptions (written from left to right), according to majority opinion, is supposed to have been derived from an older Indian script, while others believed that it was derived from the Pheonician south or north Semitic scripts. The best known Brāhmi inscription of Aśoka is the rock cut edict of Lumbini Pillar inscription (249 BCE). Several Brāhmi inscriptions are found scattered in more than thirty places through-out India, Nepal, Pakistan and Afganistan. The language of the eastern part of the Indian subcontinent is a type of Magadhi (probably the official language of Aśoka's court, Pāli dialect) where-as the language of the edicts in the western part was in Prākṛt (dialect / language), closer to Sanskrit. The Prākṛt was supposed to be the language of the common man in every-day life, where as, Sanskrit remained as the language of the Public worship. Aśoka's edicts have survived because they were written on rocks and stone pillars. The Brāhmi has various lines of successions. The northern specially gave rise to Devnāgarī. The Nāgarī script is derived from Brāhmi, it is not unlikely that Proto-Brāhmi , Brāhmi and Nāgarī brought some evolutionary changes in the language of Sanskrit, in which most of the religious scriptures are preserved. The Gupta scripts are sometimes called products of late Brāhmi scripts which are diversified local variants classified together as the Brāhmi family of scripts. **Kharoṣṭi** inscriptions (written from right to left) appeared in India around the same time as that of Brāhmi, and began to be used also for Prākṛt language / dialect, the language of the ancient kingdom of Gandhāra. A few Kharoṣṭi inscriptions on Aśokan edicts, of Śaka and Kuṣāṇa kings are found from north-western Indian subcontinent (north Pakistan, Afganistan) and other

parts. Slowly the Kharoṣṭi was replaced by Brāhmi and as a result of which the Kharoṣṭi became obsolete by 3rd century CE.

Items of trade are well-known from the account of Mc Crindle's *The Commerce and Navigation of Erythraean Sea*, being a translation of the work of Periplus and Arrian's accounts, Warmington, E. H. (1928), Moti Chandra (1977), Prasad et al (2016), and others. Some of these are: **Pepper** (*pippali* in Tamil, specially the black variety, *P. nigrum*) from the Malabar and the Travancore coast of India. In Hippocratic collection, pepper is mentioned as an Indian drug brought through Persian empire under the name of *pipri* which was the Iranian pronunciation of *pippali*. Several hundred useful and tested Indian drugs are known in the Greek *materia medica* . Dioscorides reports in his *Herbals* (I.5; I.6; I.11; I.15; I.17; III.25 & so on) on large number of plants obtained from India used for medical purposes. Pepper is referred to by Hippocrates as Indian remedies for agues and fevers, and repeatedly mentioned in the writings of Pliny, Celsus, Galen and Scibonius; **Ginger** (*gingiber, zinziber, singavra* in Sanskrit, *inchiver* in Tamil) from India and Ceylon (mentioned by Discorides, Celsus, Pliny and Scribonius, referred to as digestive); **Cardamoms** (*Elettaria cardamomum*) from Travancore, Malabar, Madura, Tinnivelly and Dindigul, used as medicine and perfume; **Cinnamon** from China and India, source closely guarded. Chinese Cinnamon travelled via Yunnan, Burma, Tibet, Sikkim to Indian ports of Tamluk, Muziris and Neleynda for export to western markets; **Liquorice** (*madhuka),* does not grow in India and was imported from Spain, Soviet Central Asia and Iran (*Wealth of India*, IV, p.152); **Oil of Spikenard** (*Nardostachys jatamansi, nalada* in Sanskrit), a Himalayan plant from Barygaza, Barbaricon, and Malabar coast; **Roots of *Costus*** (*Saussurea Lappa, Kuṣṭha* in Sanskrit) , grown in Kashmir and basins of of Chenub and Jhelum, another aromatic appearing in the drug list; **Gum-resins** (*Bosbellia thurifera*, two varieties- *glabra* and *serrata*, indigenous to Central India and Coromandel coast, another gum-resin variety *Veteria Indica*, used for fumigating clothes and as remedy from various disorder like tooth-ache appear in the accounts of Dioscorides; **Indigo** (*Indigofera tinctoria* found in ancient Egypt) & *Indikon* (Indigo from Indian rheas, V.107) transported in large quantities to the west of Barbaricon, as reported by Discordes; **Lycium** (*Raisin Baberry* growing in the Himalayas) **,** a vegetable yellow dye extracted from the roots, stems and several species of berries used as astringent for the eyes, sores, wounds and as a cosmetic; Sugar (Sanskrit *śarkarā*, Prākṛt *śakkari*, Greek σα′κλαρθν) used as a medicine by Theophrastus and Dioscorides; **Medicinal plant products** – Camphor (*Dryobalanops camphora*), Pulp of Purging (*Cassia fistula*), Guinea- grains (*Amomum Grana paradise*), Tamarind (*Tamarindus indica*), pan leaves, bettle-nuts, etc used in rare and precious medicines; **Ornamental and fragrant woods**—Ebony, Teak-wood, Sandal-wood, and other aromatic woods; **Metals** – Copper from Kulla, Garhwal,Nepal, Sikkim and Bhutan, Cyprus; Tin from Lusitania; Antimony from Kirman and eastern Arab; Manganese and Orpient from Persia and Kirman; gold from African coast; Iron and steel imported from India.; **Precious stones** —Diamond, Quartz, Opal, Crystallized silica (pure) best varieties supplied from India; Indian skill of staining rock crystals into the colours of precious stones as unrivalled Indian arts as reported by Pliny, Strabo and other Greek scholars; **Glass materials and drinks** —Glassware and lamps from Rome, and wine from Laodicea, Italy & Rome; **Textiles** (Cotton, Silk) **and Carpets** – Cotton and Silk yarn and materials from Egypt, India and China; the name Silk is possibly established from Chinese Silk-routes and subsequent exploration of routes to Sogdiana and Bactria by Chinese emperor Chang Chhien by 200 BCE; **Bamboo** (*Dendrocalamus brandisii* or Burmese Bamboo domesticated in the Southeast Asia (India- Myanmar- Thiland- South China); **Domesticated animals**—Pig (*Sus domesticus* in Tigris basin, presently Iraq), Dog *(Canis lupus familiaris* , Asia), Goat (*Capra aegagrus hircus*, in Iran for meat, milk and skin), Sheep (*Ovis aries*, Mesopotamia, presently Iraq and neighbouring countries), Cattle (Turkey, for meat, milk, skin and transport), Buffalo (*Bubalus bublis*, India & China),

Horse (*Equus feruscaballus* or *Equus cabalus*, Kazakhstan); **Domisticated crops**—Rice (*Oryza sativa*, SW China & NE India), Wheat (*Triticum monococcum*, Turkey & Syria), Barley (Syria & Iraq), Turmeric (*Curcuma longa*, India) & so on.

On the question of possible borrowing and influences of ideas, there have been many a debates. Sometimes the traditions are parallel, sometimes they interact and interfere. An attempt has been made to summarize a few instances of parallelism, convergences and interferences among these countries. In ancient India and Iran, the Law of Good order in Nature was known under similar names: *ṛta* in Vedic India, *arta* in old Persian and *asha* in Avestean language. Likewise, the *yajña* ritual in India and *yasna* ritual in Iran have the similar features. The **Vedic medicine** in its early phases dealt with the elaboration of ideas which served later to build the theories of physiology and pathology of the classical Ayurveda. The ideas of several breaths (*prāṇas*) producing movements and functions of the body and having a natural connection of bile with fire, as conceived in Vedas (*Vājasaneyī Sam*. XVII.6; *Kāṭhaka Sam*.XVII.17; *AV*. XVIII.3.5) has been maintained and developed the classical theory of *tridoṣa* in Ayurvedic texts of Caraka and Suśruta [*prāṇa* (or *vāyu), pitta and kapha* (or *śleṣman or phlegm*)]. Similar doctrine appeared in *Timaeus* of Plato (427-347 BCE). Indian tradition is much older than that of Plato. The theory of double function of wind in the universe and in the body is more or less the same in Hippocratic work *On the Winds* and teachings of Caraka and Suśruta. Filliozat says [Taton, 1957, p.156],

> "India may very well have influenced the Hippocratic collection and the *Timaeus* particularly, since Plato failed to mention his sources, and since, moreover, his doctrine is closer to the Indian than to that of any contemporary Greek school".

The **theory of *tridoṣa***, three vital elements (*vāyu, pitta* and *kapha*), one of the essential principles of Indian Ayurvedic medicine, is very similar to the theory of four Greek humours (black bile, yellow bile, blood and phlegm). The Greek theory is far wider in their meaning and function and appears to be of later origin. Some correspondence are found in the astrological work of *Yavanajātaka* from comparison of effects of planets (Pingree ed., 1978, Vol. 2, pp.244-45; see also Michio Yano, 2005, pp.50-51) thus:

Saturn: *vāta* (Indian) = black bile (Greek);

Sun & Mars: *pitta* (Indian) = yellow bile (Greek);

Jupiter: *kapha* (Indian) = blood (Greek);

Moon & Venus: *kapha* + *vāta* (Indian)= phlegm (Greek); and

Mercury: *vāta* + *pitta* + *kapha* (Indian) = changeable (Greek).

Some similarities are traceable, though it is not easy to decide who borrowed whom. Needham reports (1954) a *Po-lo-men Yao fang*, a brāhmānical work dealing with Indian pharmaceutics introduced into China, the exact content of which is not clearly known. *Milinda panho* (2nd century BCE), a Buddhist doctrine containing a dialogue between Bactrian Greek King Milinda and a Buddhist sage Nāgasena, has summarized many things similar to those of *Caraka-saṃhitā* (*CS*). The *CS* was also translated into Pahlavi languages in the early centuries of the Christian era besides a few other texts. It has mentioned a physician, named Kankāyana from Bāhlika; Bhattāra Hariścandra, the illustrious and the first commentator on *CS* is also from Bālhika. Two important drugs—*keśara* (saffron) and *hingu* (*asafetida*) are known by their synonym *bāhlika*, which according to P.V. Sharma show their ecological or commercial relation with the region of Bāhlika. The Bower manuscript, obtained by Major General L.H. Bower, from Kucha (Kuon Uyghur, an ancient Buddhist Kingdom located on the branch of Silk-route near Taklauan Desert in the Tarim basin) which was buried in sand and found while digging, is translated by distinguished scholar, Rudolf Hoernle, and is a collection of three books, known as *Navanitaka* (Cream) on medical remedies of 2nd century CE. It has quoted many formulae from CS with reference to Agniveśa. Another medical work, *Yogaśataka*, written in Sanskrit and accompanied by its Kuchean translation of the 7th century CE was found from the

same region. The Sanskrit manuscript of *Yogaśataka* found also in Nepal, Ceylon and various parts of India, also in Tibetan translation and monasteries are often guessed having Buddhist influence behind these activities. The Greek name of *opion* (opium) appears in the Ayurvedic text as *aphena* or *ahiphena*, may have been introduced lately from the Arabic medicine, *afyun*.

In astronomy there are many points of similarities, interactions and exchanges of ideas taking place in the period. The oldest Vedic astronomy had a ecliptic sidereal system with capability of predictions of Sun. Moon, their periods, and passage of the Moon through a select list of 27 or 28 *nakṣatras* (constellations) in the sky and provide us with some elements of observational astronomy. The *nakṣatras* served more or less the same purpose for the Indians, Babylonians, Chinese and others. The Babylonian used originally 24 constellations raising it to 33, according to Thibaut. The Chinese *hsius* originally restricted to a limited number to mark the equator and facilitate the culmination of heavenly bodies, later on replaced by 28 *hsius* in *Huai Nan Tzu of Liu-an* (160 or 150 BCE) to mark the lunar zodiac, which according to Biot, is the result of Indian influence. The catalogue of Sui dynasty, completed in 610 CE by Wei Cheng has also mentioned a number of works on astronomy and mathematics, all beginning with the words *'Po-lo-men'* meaning 'Brāhmanical referring to Indian influence. Systems of time cycles or Great Year are also similar. Indians had four *Yugas — Kṛta, Tretā, Dvāpara* and *Kali*, known from very early times. The *Mahābhārata* itself states that the *Bhārata war* was fought at the commencement of *Kali Yuga*. Āryabhaṭa I, the pioneer Siddhāntic astronomer & others said that the Great Year was made of the total duration: 1,080,000 x 4 = 4,320,000; *Kalpa* = 1000 *Yugas* = 4,320,000,000. The *Kali Yuga* was given astronomical recognition by Vṛddha Garga and others by assigning an obscure motion to the *Śaptarṣi* (Great Bear). That these notions are very old is clear from the reference of 10,800 as the number of *muhūrtas* (moments) in a year, according to the *Śatapatha Brāhmaṇa*. A Babylonian astronomer Borossos (4th century BCE) of (2,0,0,0 in sexagecimal unit) or 432,000 years , and the Great Year of the Greek scholar Heraklitos having a duration of 10,800 years, might have some influence from India during Achemenid dynasties, as the Indian ideas are more ancient. The *Śaka era* in north-India on the other hand might be an influence of Śaka rulers of Central Asia. It was established when 3179 *Kali* year had expired, and the Kuṣāṇas, a Śakish tribe, established a kingdom within the Indian soil by omitting the 100th place from the' Old Śaka era' from the time of Kaṇiṣka in 78 CE[1]. Accordingly,

3179 *Kali* year (expired) = 0 *Śaka* year (expired) = 78 CE

Gupta dynasty was established subsequently and their inscriptions were dated in months, *tithis*, year and a new Jovian year (time Jupiter stays in a sign of the zodiac). From Al- Biruni's accounts, the epoch of Gupta era falls on 241 years after Śaka era, or in 319 CE (precisely March 8, 319 CE befitting *Caitra śuklādi* beginning) which has been generally accepted by the historians.

However, a great change is found in Indian astronomy with the introduction of Hellenic astrology in India by Christian era. The most remarkable element was the role played by seven planets, and the division of ecliptic into 12 zodiacal signs, called rāśi, beginning with Aries (Meṣa)

[1] Before Kuṣāṇas, the Śakas, the original inhavitants of Central Asia migrated to Iran and India and established several pockets. Under the leadership of Azes, they conquered Bactria and introduced *Śaka* year in 123 BCE as a token of victory, according to recent researches. The era of Azes is known as 'Old Śaka era' in Konow's *Catalogue of List of Inscriptions*. The Śakas under the leadership of Moga infiltrated further inside India. They were influenced by Indian culture and gradually adopted Indian names of months in their calendar but not the Indian system of *tithis* or moon's *nakṣatras,* since their calendar was within the framework of 19 years cycle (i.e. 19 years = 6939.75 days; 235 lunations = 6939.69 days) discovered by the Greek scholar Meton (c.433 BCE), a figure more refined than their other counterparts.. The Indian *Śaka* era, now in use, owes its origin to the Old Śaka era, and the credit goes to the *Śakas* who introduced in India a scientific system of date reckoning.

equating it with first point of Aśvinī. The appearance of Greek words like, *liptā* (from *lepton*) meaning minutes, *āpoklima* → inclination, *horā* → hour, *diametron* → diameter, *leo* → lion and so on began to appear. The names of the nine planets (*grahas* – Moon, Jupiter, Venus, Saturn, Mars, Mercury and Sun including Rāhu, the ascending node, and Ketu, the descending node of the Moon) and the planetary worship in India started during this time. The names of the planets appear in the *Mahābhārata, Gārgajyotiṣa*, and planetary worship in the *Gṛhyasūtras*, not in weekday order. How does the week-day order of planets were introduced in India? It may be the Jewish influence of weekly prayers or Roman influence after the name of gods, since the week-day order became a civil custom by the end of 2nd century CE, and the week beginning with Sunday (Jacobi ,1876, p.306). Originally the seven days had no special names. Subsequently, they appear as:

> **Jewish:** 1st day, 2nd day, 3rd day, 4th day, 5th day, 6th day, and the *Sabbat* day (for religious purposes);
>
> **Roman**: Dies Solis, Dies Lunae, Dies Martis, Dies Mercurii, Dies Jovis, Dies Veneris, Dies Saturnis.
>
> **Indian***: Ravi-vāra, Soma-vāra, Maṅgala-vāra, Budha-vāra, Bṛhaspati-vāra, Śukra-vāra* and Śanivāra; appearing in the *Vṛddha- yavanajātaka* of Minarāja (c. 300-325 CE).

The use of Indian table of chords might also been derived from that of the Greeks. While Greeks used double-chords in a semi-circle, Indian used half-chords in a quarter-circle which is indeed a great improvement over Greek trigonometry and made it more closer to modern sine. The similarities of Greek and Indian astronomical models of *epicycles, excentrics*, and mean anomalies as *manda kendra, śighra kendra*, etc indicate towards a common relations, but their links are not clear enough to appreciate and might have been reached independently. The precession of equinoxes, as discovered by Hipparchos, later appears in India as a part of astronomical theories of liberation (an oscillation of the Moon's face as found from the Earth). The rate of precession is more accurate in Indian calculation than in Ptolemaeus indicating that the discovery of the theory may be independent of each other. The decimal place value in India may have been inspired from the Babylonian sexagesimal system, but Indian positional notation with nine numeral and zero symbol against Babylonian use of only two symbols for one and ten and with no symbol for zero was a far better natural system. The Indian numerical system based on decimal place value was adopted subsequently by the Arabs and became widespread throughout the world. In the seventh century CE, the testimonies of several Sanskrit texts praising the knowledge of the *Yavanas* are found and marked by the existence of texts like *Romakasiddhānta* and *Pauliśasiddhānta* and summarized by Varāhamihira (c. 505 CE) in his *Pañcasiddhāntikā*. During the time of the Thang emperors (from the end of 6th century CE onwards), the Chinese had received some knowledge of astronomy, mathematics and pharmaceutics. The Indian names like, Ch'u-tan (a Chinese transcription of Indian name, possibly Gautama), Ch'u-tan Chuan, Ch'u-tan Lo (President of the Astronomical Board and his calendar *Kuang-chai*), Ch'u-tan His-ta and his calendar *Chiu-Chi-li* and so on are well known. Sarton observes (I, pp. 513-14):

> "The Chinese treatises of Ch'u-tan His-ta and I-hsing are of special value as witnesses of the penetration of Hindu mathematics in China".

The **idea or concept of metals** is as old as the human civilization and lies at the very basis of control and expansion. In India, the time cycles of civilizations were recognized by four units of *Yuga* cycles like: *Kṛta or Satya* (Gold Age), *Tretā* (Silver Age), *Dvāpara* [Bronze Age, or Chalcolithic Age with appearance of Copper & Copper-alloying with tin (about 23%), arsenic (12%) or lead (5%) in Harappan civilization] and *Kali* (Iron Age) indicate possibly the metal based social system or civilizations. There are Vedic references to *Kṛta* and *Tretā* in the *Taittirīya Samhitā* (*TS*. IV.3.3), and *Kṛta, Tretā,* and *Dvāpara* in the *Vājasaneyī Saṃhitā* (*VS*.XXX.19), and *Kṛta, Tretā, Dvāpara* and *Kali* in the *Taittirīya Brāhmaṇa* (*TB*.III.4.1) with offerings 'to protect them'. Similar definitions like, Golden

age of Crones, Silver age of Zeus, Bronze age of Wars, Heroic age of Trojan War and Iron age, were also known among the Greeks. Three types of iron tools made of wrought iron (almost pure iron having negligible quantity of carbon), cast iron (having high quantity of carbon making it hard but brittle) and steel (having carbon mixture roughly 1.7% imparting sufficient hardness without resultant brittleness) were found in India. The south Indian primitive steel was produced by fusion method by carburization of wrought iron in clay crucible. The crucibles were filled with alternate layers of wrought iron and firewood or charcoal and then sealed with clay, placed in the furnace and heated. The process of steeling—carburization, quenching and tempering (heating the metal and hammering it repeatedly while gradually cooling of) was first produced by the smiths of Konasammundrum and Dindurti, two small villages in Nirmsal district of Hyderabad in Andhra Pradesh. The south Indian words, *ukku* or *uruku* (boiling) is suggestive of crucible steel as early as 4th century BCE by a fusion process, known as 'wootz steel'. The ingots of wootz steel were taken even to Damascus through traders and Arab conquerors of India (Pant,1985, p.204). The use of Indian steel for the making of finest swords is known from the time of Ctesias and Pliny's reference to 'Seres' as source of finest iron interpreted as 'Cheras' of Malabar coast; there is also to Greek reference to Indian steel coming from Ariace (Gujarat) and a special treatise on the tempering of Indian steel. The Romans used Indian steel for making fancy cutlery and armour at Damascus and Irenopolis. The words for wootz steel were known as: *bin* and *bin-tie* (Chinese), *pulad* (Central Asia & Persia), *bolat* (Mongol), *bulat* (Russia), *p'otorat* (Armenia), *folad* or *fuladh* (Grusinian, Turkish & Arabian) etc. Donald B. Wagner (2007, pp.305-310) has reported that *bin*-iron was imported steel in China and is related to Indian wootz steel or other crucible steel which are allowed to cool slowly, and the product after finish reveal a pattern. The *pulad* or *fuladh* is referred to crucible steel and called it '*hinduwani*' by scholars like ai-Kindi (c,800-870 CE) under the Abbasid Califate, as reported by al-Nadim (10th century), and by al-Biruni (11th century) and others to crucible steel producing a pattern after finish.

Indian alchemy, as reported by Buddhist alchemist Nāgārjuna (first century CE), and famous Chinese pilgrim Hiuan-Tsang (who made a visit to India in the seventh century CE), like its counterparts in Greece, Egypt and even in China, was mainly based upon the treatment of mercurial processes in medicine and alchemy (*rasa* or *pārada*), the uses of which might have been exchanged between these countries. The mercury based astronomy in India relating to male-female symbolism, *Śiva* and *Pārvati* or *Śiva* and *Liṅgam* (meaning cinnabar or mercuric sulphide) as its creative emblem. The Chinese alchemy centered round cinnabar and based on male female symbolism of *Yang* and *Yin*. Chinese alchemy and Taoism flourished in China during the Tang period. Some intercourse is possible because interaction between India and China was at its peak between 3rd to 7th century CE (Needham, I, pp. 206-214). As regards minerals, India was recognized as the land of gems and gold. Pliny in his *Natural History* deals with precious stones (Book XXXVII), many are from India of which diamonds, opals, agate and others are enumerated (*Cambridge History of India*, ed, E.J. Rapson, Delhi, 1955). In the books of Roman traveler Celsus, there are excellent accounts of lithotomy and cataract operation following Hindu tradition, as described in the *Suśruta Samhitā*.

In the fields of art and techniques, some parallelisms are also noticed. The influence of Greek coinage in India as well as the Greco-Buddhist art of Gandhāra have similarities with rising of coinage in India, architecture and sculpture, and contributed a lot to the development of many a features in arts of north-west India. Persian wheel, a continuous water lifting device from well or tanks was known in India from the beginning of Christian era. The device had a row of earthen pots tied to the rim of a drum-shaped wheel and moved by gearing it with a wheel turned by man or animal. Modern wheel, confined to Baluschistan, Sind and Punjab and some parts of Bombay Presidency, may have been an improvement introduced into India from Persia. The

use of nitre, sulphur and charcoal in a mixture as explosive were recognized in India possibly from the Hebrews or Chinese. The Hebrews used the word 'neter' and a factory for making 'neter' in Basra is reported in ninth century. The Chinese also claim priority in the discovery in nitre and gunpowder known to Chinese alchemists from the time of Thang dynasty. However, the word *bārud*, the explosive mixture of nitre, sulphur and charcoal, as used in Arabic, Persian and Turkish, has passed on to Indian languages.

In fine, it may be said that trades and commerce had been the vehicles of interactions and exchanges of ideas among ancient civilizations like India, Iran, Greece and China and others during the Achaemenid and subsequent periods up to the time of the Gupta dynasties in India. Intercourse, though limited and occasional, have been quite fruitful. Mutual borrowings from each others establish that the highest civilizations in antiquity were not a closed world and had made consistent efforts for mutual benefits and change. We are indeed thankful to the Lotika Varadarajan and Surajit Sarkar, the Guest Editors, for initiating to organize such a seminar, though a few have been attempted before by UNESCO and other organizations. However, this is indeed a laudable collaborative effort to find some new scholars and materials to appreciate such exchanges in antiquity. Many more such collaborative efforts are needed to make the objective worthwhile for posterity.

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