

ON THE CHRONOLOGY OF ANCIENT INDIA

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The chronology of ancient India presents a fascinating puzzle. The theoretical problem at the basis of this puzzle is : Can archaeological evidence that dates back to 3000 B.C. and earlier be used to fix the dates of events from a literary evidence for which the earliest epoch is attested to about 1800 B.C. only ?¹ In the past the interpretation of the literary evidence was greatly constrained by the contemporary understanding of certain events on a broader canvas. Archaeological discoveries of the past three decades have led to new theories on the migrations of the Indo-European peoples, so that a fruitful reassessment of the diverse evidence regarding the Indian region can now be made.

The chronology of the Vedic age is also of great significance in understanding the development of later science. If the Vedic age began around 1500 B.C. then one can see why it may not have been indebted to the Harappans. On the other hand, if it goes back to the third millennium B.C. then it is necessary to determine the sciences of the Harappans to be able to understand the *milieu* in which Pāṇini and other masters worked.

There is considerable difference of opinion regarding the chronology, however. One point of agreement is that the Vedic age had definitely ended before 1000 B.C. We shall review the traditional and modern accounts of this chronology.

Traditional Views :

By the time of the *Bhārata* War the Aryans were already in North and Central India. Since the *Ṛgveda* mentions only Northwest India, the time of this War may be taken as the epoch by which the *Ṛgvedic* hymns had all been composed. According to *Purāṇas* the *Ṛṣi* Vedavyāsa, who lived during the War, arranged the hymns into the *Samhitās*. Since this fact agrees with the literary evidence, the War may in fact be taken as the end of the Vedic age. There are three traditions regarding this epoch :

1. The one due to Āryabhaṭa who claimed the War took place in 3102 B.C.

2. Varāhamihira (550 A.D.) ascribed to Garga, an earlier astronomer, the following : "The seven *ṛṣis* were in the *Maghās* when the King Yudhiṣṭhira was reigning ; his era is 2526 years prior to the *Śaka*". [*Bṛhatsaṃhitā*, 13, 3]. The first part of the statement has been interpreted variously ; the second clearly means that Yudhiṣṭhira became king in -2526 of the *Śaka* era, which is 2449 B.C.
3. According to the *Purānas* [such as *Vāyu* 99.415, *Matsya* 273.36, etc.], a total of 1050 years [in certain texts 1015, 1115 or even 1500 years] elapsed between the birth of the King Parīkṣit and the coronation of Mahāpadma Nanda. Taking 321 B.C. for the accession of Candragupta and the rule of the Nandas to have lasted 50 years, the birth of Parīkṣit becomes about 1421 B.C.

Purānas talk of two Parīkṣits, one who lived several generations before the War and the other who was Arjuna's grandson and became King after Yudhiṣṭhira. The later *Purānas* suggest that the above reference is to Parīkṣit II, though this has been disputed by scholars. Even if we accept that as a fact, we see that there exists considerable difference between the three traditions.

Attempts to construct a chronology based on the genealogies in the *Purānas*, and the references in the *Vedas* have also been made, notably by Pargiter and Bhargava.² Both these scholars take 1000 B.C. as the epoch of the *Bhārata* War, but they differ about the time of the beginning of the Vedic age, Pargiter taking it to closer to the end of the 3rd millennium B.C. whereas Bhargava takes it much earlier at around 3000 B.C.

Attempts to date the War using internal astronomical evidence in the *Mahābhārata* have been made by Sengupta.³ According to him, this evidence shows that the War took place in 2449 B.C., that is identical to the claim of Varāhamihira.

Sengupta has further shown that Āryabhaṭa's claim is in conflict with the internal evidence of the *Mahābhārata* and is thus untenable. He suggests that Āryabhaṭa arrived at his date by a back calculation using for his data the oft-quoted statement in the Sanskrit literature (including the above by Varāhamihira) that during the Pāṇḍava times the *ṛṣis*, or the stars of the Great Bear, were conjoined with the *Maghās*. "Āryabhaṭa I may have assumed from it that the summer solstitial colure of the Pāṇḍava time passed straight through the star *Maghā* or *Regulus* for which the longitude was known in his time most probably as 126° as measured from the vernal equinox. In Pāṇḍava time its assumed value was taken at 90°. This would show a solstitial shifting of 36°. If we assume further that he knew of Ptolemy's precession rate of 1° per 100 years, the time from the year of the battle to Āryabhaṭa I's time (499 A.D.) would be 3,600 years".⁴ Sengupta notes that had Āryabhaṭa used the correct rate of precession, he would have arrived at 2350 B.C. as the year of the battle.

Sengupta further argues that the dynastic lists of the *Purāṇas* mention only the main rulers and therefore the interval between Parīkṣit and Mahāpadma Nanda (c. 360 B.C.) should be taken only as a lower limit. Furthermore, the Varāhamihira tradition of 2449 B.C. is supported by Kalhaṇa in his *Rājatarāṅginī* and also in a commentary of *Bhagavatāmṛta* where it is claimed that the Buddha was revealed (483 B.C.) as an incarnation of Viṣṇu 2000 years into the *Kaliyuga*. Similarly the orthodox Bengali almanacs date the *Bhārata* War at around 2449 B.C.

Sengupta's reconstruction of the chronology of ancient India is summarized below :

Vedic Indians recognize the coming of the spring and the rains	c. 4000 B.C.
<i>Bhārata</i> War	c. 2449 B.C.
<i>Śatapatha Brāhmaṇa</i>	c. 2100 B.C.

Sengupta's work is an extension of a line of inquiry that was first started in 1893, when B. G. Tilak in Bombay and H. Jacobi in Bonn simultaneously and independently of each other arrived at the opinion that at the period of the *Brāhmaṇas* the Pleiades (*Kṛttikā*) coincided with the vernal equinox and that earlier at the time of the Vedic texts vernal equinox fell in Orion (*Mṛgaśīrṣa*). Now about 2500 B.C. the vernal equinox lay in the Pleiades and about 4500 B.C. in Orion. Tilak dated the beginning of Vedic civilization at 6000 B.C., while Jacobi contented himself with placing the beginning of that civilization at about 4500 B.C. Jacobi took the Vedic age to last the period 4500 B.C. to 2500 B.C. and he took the collection of hymns that have come down to us as belonging to the second half of this period. Jacobi believed to be confirmed in his view because in a post-Vedic marriage custom the bridegroom showed his bride the Pole Star (*Dhruva*) as a symbol of constancy. Now stars move, one after another, towards the North Pole becoming the pole Star in turn, but only rarely does such a bright star approach the Pole that it can, for all practical purposes, be regarded as the constant star. At present a star of the second magnitude, in the Little Bear is the Pole Star of the Northern hemisphere. This star cannot be meant when the Pole Star is mentioned in Vedic literature because 2000 years ago it was far removed from the Pole. In 2780 B.C. we meet with Alpha Draconis which for 500 years stood so near the Pole that it must have appeared constant to the naked eye. The custom of showing the constant star to the bride on the marriage evening as a symbol of constancy must therefore be placed in a period in which Alpha Draconis was Pole Star, that is, in the first half of the third millennium B.C. In the *Rgveda* there is no mention of this custom and hence Jacobi thought it probable that the custom had not yet come into being in the period of the *Rgveda* which therefore lay before the third millennium B.C.

Tilak's conclusions were based on an interpretation of astronomical allusion in the Vedic literature especially those related to the enumeration of the *nakṣatras*. Tilak writes :

“It appears that the oldest Vedic calendar, like the oldest hymns was sacrificial ; and that the sacrifice on the year commenced with Aditi at the vernal equinox in or near Punarvasu. The phases of the moon, the seasons and the ayanas further guided the ancient Aryas in measuring time for sacrificial purposes. The asterism of Abhijit marked the approach of Vishuvan or the central day, while Punarvasu, which soon after came to be called Yamakau, perhaps Yama and Yami, indicated the beginning of the year. Sometime after this and before the vernal equinox had receded to Orion, the lunar months and tithis or days appear to have come in use ; and in fact, the whole calendar seems to have been rearranged, the year being made to commence from the winter solstice in the Chitra full-moon. But this did not alter the sacrificial system, which, so far as the procedure is concerned, still continues to be what it was in the oldest days. For all civil purposes the new calendar was, however, at once adopted and the two systems have continued to exist side by side up to the present day, though in a considerably modified form.

“The oldest period in the Aryan civilization may therefore be called the Aditi or the pre-Orion period, and we may roughly assign 6000-4000 B.C. as its limits. It was a period when the finished hymns do not seem to have been known and half-prose and half-poetical Nivids or sacrificial formulae “giving the principal names, epithets, and feats of the deity invoked” were probably in use. The Greeks and the Parsis have retained no traditions of this period, for the simple reason that they carried with them only the calendar which was in force when they left the common home, while the Indian Aryas have preserved all the traditions with a super-religious fidelity and scrupulousness. It is thus that I explain why the oldest Greek and Parsi traditions do not go beyond Orion.

“We next come to the Orion period which roughly speaking extended from 4000 B.C. to 2500 B.C. from the time when the vernal equinox was in the asterism of Ardra to the time when it receded to the asterism of Krittikas. This is the most important period in the history of the Aryan civilization. A good many suktas in the Rigveda (e.g. that of Vrishakapi, which contains a record of the beginning of the year where the legend was first conceived) were sung at this time, and several legends were either formed anew or developed from the older ones. The Greeks and the Parsis appear to have left the common home during the latter part of this period as they have retained most of these legends, and even the attributes of the constellation of Mrigashiras, otherwise called Agrayana, Orion or the Pauryeni. We can now easily understand why no

confirmatory evidence about the Krittika-period is found either in the Rigveda or in the Greek and Parsi legends and traditions. This was pre-eminently the period of the hymns.

“The third of the Krittika-period commences with the vernal equinox of the asterism of the Krittikas and extends up to the period recorded in the Vedanga Jyotisha, that is, from 2500 B.C. to 1400 B.C. It was the period of the Taittiriya Sanhita and several of the Brahmanas. The hymns of the Rigveda had already become antique and unintelligible by this time and the Brahmadivins indulged in speculations, often too free, about the real meaning of these hymns and legends attributing the use of the foamy weapon used by Indra to a compact between him and Namuchi. It was at this time that the Sanhitas were probably compiled into systematic books and attempts made to ascertain the meanings of the oldest hymns and formulae.”⁵

The views of Tilak and Jacobi met with great opposition. It was claimed that the positions of the *nakṣatras* were defined by the Vedic Indians only in relation to the Moon and not the Sun, and there is no evidence in the Vedic literature of any observation of the equinoxes. Winternitz asserts⁶ that the passages of the *Śatapatha Brāhmaṇa* which says that the Pleiades (*Kṛttikā*) “do not swerve from the East” did not mean that they rose “due east” (which would have been the case in the third millennium B.C. and would point to a knowledge of the vernal equinox) but rather that they remained visible in the eastern region for a considerable time every night which was the case about 1100 B.C. Yet in 2100 B.C. or 3100 B.C. the Pleiades touched the east line earlier than in 1100 B.C. Regarding the argument of the Pole Star, it was said that the possibility of one of the lesser stars in the Little Bear having been visible about 1250 B.C. and even later as the Pole Star could not be denied. In spite of these criticisms Tilak’s arguments are plausible. Since literary evidence of the kind used by Tilak can, by itself, be considered to be unfalsifiable, it becomes necessary to check it by other evidence as I shall do.

The Demographic Question :

Pran Nath estimated⁷ the population of India during Aśokān times [second century B.C.] to be about 100-140 million. According to Usher the population was about 70 million around the beginning of the Christian era. By way of comparison, the entire population of Europe at this later epoch has been estimated at somewhat more than half this level (Table 1). Although the population of many nations appears to have changed in either direction over a course of centuries, I will use a population level of 30 million for India during 1500 B.C. for the rest of my argument. Assuming the same proportion between Indo-Aryan and Dravidian speaking peoples as exists now, the population of the speakers of Indo-Aryan languages at that epoch

TABLE 1
World Population to 1000
 (millions)

	A.D. 14	350	600	800	1000
Egypt	7	4	2.7	3	3
Rest of North Africa	4.2	2	1.8	1	1
AFRICA TOTAL	23	30	37	43	50
U.S.A. and Canada					
Other America					
AMERICA TOTAL	3	5	7	10	13
China	73	60	54	55	60
India and Pakistan	70	75	75	75	70
Japan	2	3	6	8	10
Asia Minor, Syria, Cyprus	14	17	11	12	10
Other South West Asia	20	24	15	15	12
Asian U.S.S.R.	5	5	5	5	5
Other East Asia	5	6	7	8	10
ASIA TOTAL	189	190	173	178	177
British Isles	0.4	0.3	0.8	1.2	1.7
Spain, Portugal	6	4	3.6	4	7
France, Belgium, Holland	6.6	5	3	5	7
Italy	14	5	4	4	5
Greece	3	2	1.2	2	5
Rest of S. E. Europe	2	3	1.8	3	
Germany and Austria	3.5	3.5	3.1	4	4
Russia, East Europe, Hungary	4	4.8	2.8	6	9.5
EUROPE	39.5	27.6	19.3	29.2	39.2
OCEANIA	1	1	1	1	1
WORLD	256	254	237	261	280

may be estimated to be 24 million. No migrations of the Indo-European people to India in the second millennium B.C. can be visualized that involves even a small fraction of this population. Any real migrations could not have been of an extent that could have imposed an alien language on a general population of more than twenty million. Consider further that the Harappan world was already urbanized and heavily populated by contemporary standards. This leaves the hypothesis that the Harappans were essentially Indo-Aryan as the only plausible alternative.

This argument does not rule out the possibility that the Vedic Indians represent a particular migration that occurred in the second millennium B.C. But if they did arrive in India during that period, they must have encountered people already speaking Indo-Aryan languages. Is it possible that the Vedic people spoke Sanskrit, whereas the other inhabitants spoke a variety of *Prākṛt* languages? To answer this question one needs to consider other kinds of evidence.

Literary and Archaeological Considerations :

The first attempts to construct a chronology of the Vedic period based on literary evidence was by Max Müller. Since Buddhism presupposes the existence of the entire Vedic literature, he reasoned that the *Brāhmaṇas* could not have been compiled in less than 200 years, and that the *Vedas* must have taken a similar period to compile. By assigning another 200 years to the earliest hymns, he fixed 1200 B.C. as the beginning of the Vedic age.

The epoch of 1200 B.C. was in reality determined by the constraint of 1500 B.C. being the time when the Iranians moved south into their country. It was then believed that the Iranians and the Vedic Indians were the same people and, since the *R̥gveda* recognizes no region but North West India, it required a few centuries for the Vedic Indians to have forgotten the country of their origin. Max Müller's chronology was immediately criticized by many scholars on the grounds that the assignments of 200 years to each phase is totally arbitrary, that the *R̥gveda* itself exhibits a long period of poetical activity, and that there is a wide chronological distance between most of the hymns of the *R̥gveda* and the remaining Vedic literature. Since the Vedic schools of Baudhāyana and Āpastamba originated in the South, one also requires that the conquest of the South by the Aryans must have taken place quite early, perhaps by the 7th century or 8th century B.C. This implies conquest of the entire subcontinent of India within 7 or 8 centuries which was unacceptable to many scholars including Bühler and Winternitz. They pointed out that the comparison with the conquest of America in just a few centuries was wrong because the Aryans were continuously fighting amongst themselves, and had to contend with races that had an equally advanced culture.

Oldenberg has shown that the Buddhist literature presupposes not only the *Vedas* but also *Vedāṅgas*. Furthermore, by the time of the *Brāhmaṇas* many hymns of the *R̥gveda* were no longer understood. There are hymns that speak of 'old songs' suggesting that such poetry had been practised since times immemorial. One must, in addition, contend with the evolutionary nature of the hymns from the point of view of ideas that requires several centuries. Other opinions on the period of the *Vedas* include 2000-1500 B.C. by A. Kaegi, 2500 or 2000-750 B.C. by H. Winternitz, and L. Renou's ± 2000 B.C. for arrival of the Aryans and the oldest hymns.

It has been assumed by some that horse-breeding tribes that moved across Central Asia during the end of the third millennium B.C. were the ancestors of the Indo-Aryans. These peoples appear to have entered the Iranian plateau around 2000 B.C., and we find evidence of their languages at this time. The Kassites, who ruled Babylon for about 600 years (up to 1171 B.C.) and worshiped Vedic deities such as *Sūrya* and *Marut* had Indo-Aryan names, as did the Mitannis of a neighbouring kingdom. A treaty of the Hittite King Subiluliuma and the Mitannian Mattiwaza of 1380 B.C. mentions the Aryan gods *Mitra*, *Indra*, and *Varuṇa*, and among the Bogazkoy tablets is a treatise on horse training by Kikkuli of Mitanni using chariot racing terms in virtually pure Sanskrit. It is further assumed that during the first half of the second millennium the Iranian speaking tribes were still located further north in Sogdia and Bactria while the Indo-Aryans spread out across Iran into West Asia and also eastwards into India proper. The Iranians themselves advanced southward into Iran only around the fourteenth century B.C. displacing some of the earlier Indo-Aryans who now moved east. This reconstruction thus assumes two main periods of Indo-Aryan migration into Northwestern India, the first period dating around 2000 B.C., and the second some six centuries later. The Allchins have in their book⁸ investigated this reconstruction from several angles.

This above view agrees with the re-examination of the literary evidence by T. Burrow⁹ according to whom the inhabitants of the region extending from India upto West Asia during c. 2000 B.C. may be called proto-Indoaryans. After the Iranians occupied their new country the proto-Indoaryans were split up into two groups, the predominant one being in India and the smaller one to the west of Iran. Subsequent to the founding of the Mazdayasnian religion by Zoroaster, its new adherents set out to convert the proto-Indoaryans, the *deva*-worshippers, to their religion. The struggle between the two groups led the Mazdayasnians to label the gods of its opponents as demons. This explains the dichotomy of Iranian *daeva/ahura* as well.

The reconstructions of Burrow and the Allchins create one problem. If the earliest hymns of the *R̥gveda* are now to be dated back to around 2000 B.C. these should portray the intense interactions that the proto-Indoaryans must have had with the Harappans, and at the same time the Harappan iconography must reflect the same interaction. The *R̥gveda* does speak of struggles with the *dasyus* and the *panis*, but there is no reciprocal representation of the horse, that must have played a crucial role in such a hypothetical interaction, in the iconography of the Harappans. On the other hand, there is evidence of 'ritual hearths' suggestive of the Vedic fire altars from the beginning of the Harappan period itself. Now one cannot argue that the mature Indus civilization somehow came to sudden end around 2000 B.C. because there is overwhelming evidence of cultural continuity between the Harappan and the later ages. The only conclusion that remains is

that the coming of the Aryans must be anterior to the Harappan age. This is corroborated by considering the *Rudra* of the Harappan iconography. If this is the later god of the *Rgvedic* pantheon then the early hymns of the *Rgveda* must belong to an epoch earlier than the flowering of the Harappan culture—in other words to around 2500 B.C.

With regard to the *dasyu/aryan* dichotomy it should be further added that the Iranian *dahyu* means 'country'. The Sanskrit *dasyu* (foreign slave) would then represent an epithet for the Iranians viewed from the outside. According to Benveniste¹⁰: "If the word referred at first to Iranian society, the same by which this enemy people called themselves collectively took on a hostile connotation and became for the Aryas of India the term for an inferior and barbarous people. Thus the connexion between the sense of *dahyu/dasyu* reflects conflicts between the Indian and Iranian peoples".

Many archaeologists now believe that the presence of Indo-Aryans in India by 3000 B.C. should be accepted. These arguments are well summarized by Dyson.¹¹ Note that an early presence of Indo-Aryans is in consonance with the presence of the Kurgan culture in the steppes of Central Asia in the fifth and fourth millennia B.C. The Kurgan culture is generally taken as representing early Indo-Europeans.¹²

The brilliant proposal of Mahadevan¹³ in identifying the cult object on the famous unicorn seals with the ritual of pressing *soma* is worthy of discussion here. The cult object is depicted as a device consisting essentially of two parts: a generally cylindrical upper vessel and a hemispherical lower vessel with a long stem at the base. Mahadevan has provided many arguments suggesting that the object is a filter, the upper vessel acting as a strainer and the lower perforated bowl as a sieve. He has also been able to show several parallels with the *Rgveda* indicating how this device was used to produce *soma*. The pairing of this device with the unicorn (*urus ox*) becomes clear once it is noted that in the *Rgveda* *soma* is frequently compared to a bull. Also several references to *Indra*, the greatest drinker of *soma* become understandable as personification of the attributes of the drink.

The filter symbols occur in the lowest strata at Harappa. This would suggest that the *Soma* ritual was already important in the Harappan civilization in its earliest phase (c. 3000 B.C.). Mahadevan now theorizes that the Aryans took over the *Soma* ritual from the Harappans. This last conclusion cannot be accepted because if the Aryans were anterior to the ritual as well as the worship of *Rudra* then *Rgveda* would have not shown up the gradual development from the worship of the Vedic deities to the later worship of *Rudra* and *Vishnu*. The only other possibility is that the Harappans were themselves a part of the Indo-Aryan world. By Indo-Aryan we do not imply a culture that was exclusively Indo-European, but rather a fusion

of this with the Dravidian culture, which is easy to comprehend if the early Indo-Aryans and the Dravidians had already co-existed and interacted for centuries.

One might object to the above view because the archaeological remains after the Harappan phase exhibit a marked deterioration, and that one has to wait a passage of several centuries before urban centres rivalling Harappa and Mohenjodaro are encountered. To counter these objections one might argue that it is not unusual for buildings in a certain phase in a civilization to be finer than those in later ones without indicating a break in cultural continuity. Consider, for example, Kashmir where subsequent to the period of the great temples of Avantivarman and Lalitaditya, no similarly lasting buildings were built for a thousand years. Other examples can be quoted for Egypt, Babylon, Greece, and India itself. The explanation for such distinct phases can only come from a detailed history of the region, which we do not have for the Harappan age. It is also necessary to remember that the Indo-Aryans were not a single tribe, but rather they must be viewed as many different people united by common ritual and related languages. The sub-cultures of the larger Vedic civilization must have had their own separate and distinct destinies.

Our reconstruction of the Vedic age is then as follows. By the middle of the fourth millennium B.C. the Indo-European and the Dravidian worlds had already interacted and met across North-West India and the plateau of Iran. In North-East India there were more languages involved that included Munda and Mon-Khmer languages. The Indo-European world at this time must have already stretched from Europe to North India, and just below it lay the Dravidian people. The interaction for centuries between these two powerful peoples gave rise to the Vedic language which, though structurally Indo-European, was greatly influenced by the Dravidian language.¹⁴ The Vedic civilizations was a product of the civilizations of these two peoples as was the Harappan civilization. Also new bands of Indo-European speaking peoples kept on pouring in at irregular intervals such as at the end of the third millennium and the middle of the second millennium as is commonly accepted.

The above reconstruction makes it easy to understand the current demography of the Indo-Aryan languages. Given that minorities have generally been left to themselves in India, the only way one can explain the absence of Dravidian speaking minority groups in North-West India (excepting the 400,000 speakers of Brahui) is to accept that the period of the mutual interaction between the Aryans and the Dravidians must have lasted thousands of years. There is no mention of such Dravidian speaking people in North India in documents going back even 2000 years and earlier. The *Prākṛts* of the times of the Buddha and later were Indo-Aryan. Therefore the hypothesis that the Aryans first arrived only in 2000 B.C. cannot be accepted.

We see, thus, that the traditional history of India is vindicated in its essentials, and it is not in conflict with a modern analysis of archaeological and literary evidence. It was noted long ago that "from the point of view of Indian history there is no argument against the presumption that the Vedic literature reaches as far as the third millennium and ancient Indian culture reaches upto the fourth millennium".¹⁵ This does not validate the dates such as the ones proposed by Tilak, Jacobi, and Sengupta, yet it brings those dates to the realm of possibility. It becomes necessary to intensify archaeological and literary researches (including study of the Indus script) to evaluate further the correctness of their chronology.

Our reconstruction also solves the long-standing problem of the non-mention of bricks in the *R̥gveda* even though bricks are essential to a great deal of the Vedic ritual. The mention of bricks (*iṣṭakā*) is first made in the *Taittirīya Saṃhitā* where they are discussed at length in connection with *Agnicayana*—the ritual construction of the sacred fire altar. The Iranians have the same root *iṣṭ-* for a brick. Now if the *R̥gveda* was composed after 2000 B.C., it would have been familiar with the ruins of the Harappans. Indeed, these ruins would have been particularly spectacular then. On the other hand, the fact that the *Yajurveda* and the *Śatapatha Brāhmaṇa* give an extremely important role to bricks in their ritual, as well as the fact that the root for brick is the same for the Iranians, gives 1500 B.C. as the *terminus ad quem* for the development of the brick-based fire altar ritual. Furthermore, this requires that the *R̥gveda* be dated anterior to the rise of the highly developed brick technology of the Harappans. This implies a rough dating of 3000 B.C. for the *R̥gvedic* hymns and a period coeval with Harappan age for the early versions of the *Taittirīya Saṃhitā* and *Śatapatha Brāhmaṇa*, as well as the techniques of altar construction, that were eventually codified as the *Śulbasūtras*. Note that no other dating is compatible with the brick problem. We also emphasize that our dating does not imply that the language of the *Saṃhitās* and other texts did not change with time during oral transmission. As has been shown by Grierson for the case of Lalleśvari's *Vākya*, oral transmission, even when attempting to be totally accurate, reflects the continuing changes of a language.

Since an assumed chronology of ancient India is always at the basis and evaluation of Indian science, it appears that the above reconstruction would require a revision of our understanding of, say, Indian astronomy. We add that our chronology agrees with the history of the birth of geometry and mathematics as sketched by Seidenberg.¹⁶ Our chronology makes the logical precedence of Vedic mathematics over Babylonian and Greek mathematics into a temporal precedence as well.

To summarize, we have shown that the hypothesis that the Aryans first arrived in India around 2000 B.C. is in contradiction with literary and archaeological evidence. We propose, therefore, that the presence, in India, of the Aryans in the

fourth millennium B.C. be considered as a working hypothesis. There is considerable evidence in favour of this hypothesis, and at present there is no evidence that goes against it. The scientific method requires that no hypothesis not yet falsified, *but potentially falsifiable*, be ever rejected. Our hypothesis (the essential Tilak-Jacobi-Sengupta hypothesis)¹⁷ is favoured by much archaeological and literary evidence and is falsifiable. The decipherment of the Indus script, for example, can bring out evidence that could go against this view.¹⁸ However, as things stand, our reconstruction appears to be the most likely scenario.

NOTES AND REFERENCES

¹Recent excavations have shown farming settlements in the Indus valley that go all the way back to 6000 B.C. (Jarrige, J. F. and Meadow, R. H., Antecedents of Civilization in the Indus Valley, *Scientific American*, 243, 1980, pp. 122-133). On the other hand the earliest reference to Vedic gods can be found amongst the Indo-European Kassites in Babylon c. 1800 B.C. For Vedic references in the Harappan world see Kak, S. C., On the Decipherment of the Indus Script, *Indian Journal of History of Science*, 22, 51-62, 1987.

²Bhargava, P. L., *India in the Vedic Age*, Lucknow, 1971, also discusses the assumptions of Parpiter. The traditional views are described more fully in Agrawala, G. C., (Editor), *Age of Bhārata War*, Delhi, 1979. See, in particular, the paper by K. C. Verma in this volume.

³See, for example, Sengupta, P. C., Bhārata-battle Traditions, *Journal of Royal Society of Bengal Letters*, 4, 393-413, 1938.

⁴Sengupta (1938) p. 396. If Sengupta is right then Āryabhaṭa perhaps felt certain of his interpretation by the approximate mean conjunction of the planets in 3102 B.C. that fitted in with the *Kalpa* theory that momentous events occur at such conjunctions.

⁵Tilak, B. G., *The Orion*, Poona, 1893, pp. 205-207.

⁶Winternitz, M., *A History of Indian Literature*, 1907, Indian Edition, Delhi, 1981.

⁷See Clark, C., *Population Growth and Land Use*, London, 1977, for a resume. Table 1 is derived from this book.

⁸Allchin, B. and Allchin R., *The Rise of Civilization in India and Pakistan*, Cambridge, 1982.

⁹Burrow, T., The proto-Indoaryans, *Journal of the Royal Asiatic Society*, 2, 123-140, 1973.

¹⁰Benveniste, E., *Indo-European Language and Society*, Coral Gables, 1973.

¹¹Dyson, R. H., Jr., Paradigm Change in the Study of the Indus Civilization in G. L. Possehl, (Editor), *Harappan Civilization*, New Delhi, 1982.

¹²Gimbutas, M., Proto-Indo European Culture : The Kurgan Culture during the Fifth, Fourth, and Third Millennia B.C., in G. Cardona *et al.*, (Editors), *Indo-European and Indo-Europeans*, Philadelphia, 1970.

¹³Mahadevan, I., The Cult Object on Unicorn Seals : a Sacred Filter, *Purātattva*, Nos. 13-14, 1983.

¹⁴Burrow, T., *The Sanskrit Language*, London, 1955.

¹⁵Winternitz (1907), p. 278.

¹⁶Seidenberg, A., The Ritual Origin of Geometry. *Archive for History of Exact Sciences*, **1**, 488-527, 1962; Seidenberg, A., The Origin of Mathematics, *Archive for History of Exact Sciences*, **18**, 301-342, 1978; van der Waerden, B. L., *Geometry and Algebra in Ancient Civilizations*, Berlin, 1983.

¹⁷Our juxtaposition of traditional and modern views should not be taken as an endorsement of the details of the Sengupta chronology, especially with regard to the dates of the Bhārata War and composition of the Taittirīya Saṃhitā. This is because many literary sources of the Vedic times have come down in late versions. Furthermore, the astronomical evidence has been interpreted somewhat differently by other scholars. Also, a prudent principle to follow is to take a date from late literary evidence as being confirmed only when there is corresponding archaeological and epigraphical evidence.

¹⁸Our own study of the Indus script suggests that some Indus texts may have Vedic names. Using frequency characteristics I have also been able to show that Brāhmī is derived from Indus.