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ABSTRACTS OF PAPERS

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VEDIC MATHEMATICS

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Abstract : The Vedic cult had no temple. Special care was taken for construction of various shaped altars on which the ceremonies were performed. The vedic people made interesting synthesis. They made *nitya* (perpetual or daily) and *kamya* (optional for wish fulfillment) vedis for sacrifices or offerings. The first was supposed to bring happiness for the family, and the second was to give material progress. The tradition is very old in India and interesting details are found in the Samhitas, Brahmanas and the Sulbasutras.

Three vedis viz *Garhapatya*, *Ahavaniya* and *Daksinagni* having shape of a circle (*mandala*), square (*samacaturasra*) and semi-circle (*ardha-mandala*) respectively and covering the same area of one square *vyayama* (one *vyayama* = 96 *angulas*) come under the category of *nitya agnis* and were obligatory for daily sacrifice. They had 21 bricks in each layer. The *kamya vedis* or *citis* had various shapes in the form of falcon birds *syena, alaja* or *kanka*), triangle (*prauga*), rhombus (*ubhayata prauga*), isosceles trapezium (*mahavedi, sautramani* or *saumiki vedi*), circle (*rathacakra*), tortoise (*kurma*) etc and each covered an area of 7 ½ sq. *purusas* (one *purusa* = 120 *angulas*) with 200 bricks in each layer. In general these altars had five layers of bricks, first , third,and fifth layer of bricks being common, so was second with fourth. These construction problem led to the discovery of extremely interesting mathematical problems like construction of many a geometrical figures and their transformation of one figure to another, number theory, fixation of value of π , $\sqrt{2}$ (correct to five places of decimal) , discovery of Pythagorian triplets including general statement of the theorem of square on the diagonal. The main purpose in the paper is to discuss the background , antiquity and origin of some of these important concepts in broad international perspective.

1. Introduction

The Vedic cult knew no temple. The ceremonies were performed either in the sacrificer's house or on a plot of ground nearby. The ceremonies performed at the sacrificer's house were known as *nitya* (or perpetual) *agnis* and were offered daily. For nitya agnis, oblations were performed on *vedis* made of bricks (altars). There is reference of three *nitya agnis* in three places together (*RV*. 5.11.2). These are *Garhapatya* (square or circle), *Ahavaniya* (square) and *Daksinagni* (semi-circle). The *Garhapatya* is mentioned several times as a square in the *Rgveda* (*RV*. 1.15.12; 6.15.19; 10.85.27and so on). The first clear mention of the *Garhapatya* as a circle of one sq. *vyayama* and of the *ahavaniya* as a square or rectangle of the same size appears in the *Satapatha Brahmana* (*SBr*.7.1.1.37). It also mentioned that the *vedi* is to be constructed with 21 bricks.in each layer (*Tait.S*.5.2.3.5; *Mait.S*.3.2.3; *Kath.S*.20.1; *KPS*.32.3; *SBr*.7.1.1.34). Usually there were five layers of bricks, first,third and fifth layers were same, so was second and fourth layers. The *nitya agnis* were part of the daily sacrifices, raised towards east, and meant for peace and happiness of the family (*RV*. 7.35.7).

The ceremonies performed outside at a nearby plot of ground are known as *kamya agnis* . These were usually ordained by the kings (*hota* or *adhvaryu*) on specified *vedis* or *citis* and organized on a large scale. These were done for a specific purpose or wish- fulfillment. These *vedis* included *Syenacit* (in the form of a bird, *syena*), *Vakrapaksa-vyastapuccha-syena* (*syena* bird with curved wings and tail), *Kankacit* (falcon bird), *alajacit* (falcon bird), *Praugacit* (isosceles triangle), *Ubhayata-praugacit*(rhombus), *rathacakracit* (chariot wheel), *Smasanacit* (isosceles trapezium), *Kurmacit* (tortoise) and so on. Some of the main *vedis* also included M*ahavedi* (isosceles trapezium), *Darsapaurnamasa*(isosceles trapezium) , S*autramani* (isosceles trap.), *Paitrki* (square) , *Asvamedha* and others. The spatial magnitudes of the falcon shaped fire altar were also given in almost all the earlier works from the *Taittiriya Samhita* onwards. The measurements were made with units like *aratni*, *vyama*, *vyayama*, *purusa* etc. The area on which these citis (fire-altars) were drawn covered seven and half sq.*purusas* (7 ½ sq. *purusas*).(*Tait.S* .5.2.5.1; *Mait.S* .3.2.4). The *kamyacitis* also had usually five layers of bricks of 1000 bricks, each layer containing 200 bricks(*Tait.S* .5.6.8.2-3). The Satapatha Brahmana describes all these kamyacitis measuring 7 ½ sq. purusas (SBr.3.5.1.1-6). The mahavedi(also known as saumiki vedi) is described in the form of isosceles trapezium with face 24 prakramas (padas), base30 prakramas and altitude 30 prakramas (Tait.S. 6.2.4.5; Mait. S. 3.8.4; Kath. S. 25.3; KPS.3.8.6). As regards objective, or philosophy behind these construction, Taittiriya Samhita says,' One may construct syenacit, kankacit, alajacit desiring heaven, prauga, ubhayata-prauga and rathacakracit for anhilation of rivals, dronacit for gaining food, smasanacit for attaining the place where the forefathers have gone and so on (Tait.S.5.4.11.1-3). The Yajurveda gives also an elaborate and tedious method of construction of these fire-altars, associated with highly speculative philosophy. The same mystic significance is found almost in all the school of this samhitas, e.g. *Taittiriya, Maitrayaniya, Kathaka-Kapisthala* and the

Vajasaneya. This shows that the *agni-cayana* and its philosophy had already taken a definite shape in the time of the Yajurveda. The *Taittiriya Samhita* also refers to the existence of different specialists of this science with independent views (*Tait.S.* 5.2.8.1-2; 5.3.8.1; 5.5.2.1).

A small number of Sulbasutras[1] attached to Srauta section of the Yajurveda schools are now available which describe in details the knowledge of geometry and mathematics arising out of the construction of these vedic altars. Of the various *Sulba* works, those of Baudhayana, Apastamba, Katyayana and Manava are best known and are available, others are known through references. Most scholars believe that both Baudhayana and Apastamba flourished before Panini and other Sulbakaras after Panini. P.V.Kane (*History of Dharmasutras*, Introduction) placed the time of Baudhayana, Apastamba and Katyayana between800 BC and 400BC, and Ramgopal between 800 BC to 500 BC in his *India of the Vedic Kalpasutras*. A few commentaries on the *Sulbasutras* are available which added meaningful interpretation. These are Dvarakanatha's commentary (*Sulbamimamsa*) on the *Baudhayana-sulba*, Kapardisvami, Karavindasvami and Sundararaja's commentary on the *Apastamba-sulba*, Karka and Mahidhara's commentary on the *Katyayana-sulba* and so on. For details, vide Sulbasutras with Text, Eng. tr.and notes by Sen and Bag (1983). A visual representation of the different *agnis* and *citis* may be had from Appendix 1.

Our knowledge of vedic mathematics are based on these sources and traditions. What follows, you will find a value system and all round professionalism attached to the construction of these altars which marked a tremendous progress at such an early phase.

2. Units

Standarisation of units is the first step of all measurements. The traditional vedic units used in the construction of vedic altars were codified by Baudhayana in a table as follows: 1 *angula* = 14 anus = 34 tilas, 1 small pada =10 angulas, 1 pradesa = 12 angulas, 1 pada = 15 angulas, 1 isa = 188 angulas, 1 aksa = 104 angulas, 1 yuga = 86 angulas, 1 janu =32 angulas, 1 samya = 36 angulas, 1 bahu = 36 angulas, 1 prakramas = 2 padas, 1 aratni = 2 pradesas= 24 angulas, 1 purusa = 5 aratnis = 120 angulas, 1 vyama = 5 aratnis, 1 vyayama = 4 aratnis= 96 angulas (1 angula = ¾ inch ,approx.). The units like angula, pada, prakrama, pradesa, bahu and aratni had a long tradition and were used earlier in the Samhitas and the Brahmanic literature in the same sense as those in the Sulbasutras (Bsl.1.2). The terms reveal that these were coined from body measures being commonly used in daily life, and became quite popular in social life. Purusa was possibly the height of a n average man with out-stretched hands. It also appears that the heights were marked by a bamboo pole. The units were used both for linear and sq. measure. The unit of angula, even though it is a relative measure, of course created no problem as the measurment was restricted to the finger measurment of the *hota*, the sacrificer.

3. Bricks and the areas of figures

The altar makers used mud bricks for construction of altars. The bricks were specifically made and no broken bricks or bricks with cleavage were used for the purpose. The *nitya agnis* had 21 bricks in each layer covering an area of one sq. *vyayama*. .For a sq. altar in which sq. bricks were used, Baudhayana says three kinds of bricks having their sides 1/ 6, 1/ 4, and 1/ 3 of the side of the altar (i.e. one *vyayama*) should answer for the construction. This suggests that the first layer used two types of bricks, and the second layer also two types, one type of bricks was common in both the layers.

Baudhayana gives the solution correctly, since $9/6^2 + 12/4^2 = 1$, and $16/6^2 + 5/3^2 = 1$. How the bricks were made? There is no doubt that the bricks were made by drawing parallel lines to the sides of a square having area of one sq. vyayama.

The *kamya citis* had 200 bricks in each layer covering an area of 7 ½ sq, purusas. Construction of bricks for these type of altars are indeed a tremendous exercise, sometimes the area of 7 ½ sq. purusas was covered with 125 bricks and the instruction was given to replace the original bricks by its half, quarter, one-eighth bricks to fulfill the desired number of 200 bricks in each layer. The bricks were also used as units for measuring, calculating and verifying the accuracy of the measured area. The sq. bricks, *caturthi* (side one-fourth of a *purusa*), *pancami* (side one-fifth of a *purusa*), *sasti* (side one-sixth of a *purusa*), and their subdivisions were manufactured, and each was named separately. The bricks were made by special class of specialists. The dimension of a few major bricks and their subdivisions with names are given here:

***I. Caturthi* and its subdivisions (8 types) :**

(a) *caturthi* (sq. quarter of a *purusa*) = 30 *ang.* x 30 *ang.*,

(b) *ardha* (triangular half of *caturthi*) = 30 x 30 x 30√2 (ang.),

(c) *trasra padya* (triangular quarter of *caturthi*) =30 x 15√2 x 15√2 (*ang*.),

(d) *caturasra padya* (sq. quarter of *caturthi*) = 15 x 15 x 15 x 15 (*ang*.),

(e) *caturasra astami* (rectangular) = 15 x 7 ½ x 15 x 7 ½ (*ang.*),

(f) *caturasra astami* (triangular) = 15 x 15 x 15√2 (*ang*.),

(g) four sided *padya* [quarter *caturthi* after joining bricks(e) and (f)] = 22 ½ x 15√2 x 7 ½ x 15 (*ang*.),

(f) *hamsamukhi* [pentagonal half of *caturthi* when two bricks of type

(g) are joined]
= 7 ½ x 15√2 x 15√2 x 7 ½ x 30 (*ang*.).

II. Pancami and its subdivisions (10 types):

(a) *pancami* (sq. fifth of a purusa) = 24 x 24 (*ang*.),

(b) *adhyardha – pancami* (rectangular brick, side longer by one-half) = 36 x 24 (*ang*.),

(c) *pancami-sapada* (rectangular brick, side longer by one-quarter) = 30 x 24 (*ang*.),

(d) *pancami ardha*(triangular half)= 24 x 24 x 24√2 (*ang*.),

(e) *pancami padya* (triangular quarter) =24 x 12√2 x 12√2 (*ang*.),

(f) *adhyardha-ardha* (triangular half of *adhyardha*)
= 36 x 24 x 12√13 (ang.),

(g) *dirgha-padya* (triangular quarter bricks of *adhyardha* with larger base) = 36 x 6√13 x 6√13 (*ang*.),

(h) *sula-padya* (triangular quarter brick of *adhyardha* with shorter base) = 24 x 6√13 x 6√13 (*ang*.),

(i) *ubhayi* [triangular brick when brick types (f) and (g) are joined = 30 x 12√2 x 6√13 (*ang*.),

(j) *pancami-astami* (one-eighth triangular brick of *astami*)
= 12 x 12 x 12√2 (*ang*.).

III. Sasthi sq. brick = 20 x 20 (ang.); Dasami sq.brick= 12 x 12 (ang.)

There were various other types of bricks which were prepared to meet the requirement for covering altar of specified size.

IV. Measurment of Area: Baudhayana used to divide square or rectangle

by parallel lines for construction of square or rectangular bricks required for *Garhapatya* altar (Bsl.7.4 – 7.8). He had clear idea that for square, one unit in length produces one sq. unit area, two units produce four sq. areas and so on. For rectangle ABCD, if the length AB has x units and breath BC has y units, the area would be x.y = xy sq. units (Asl. 3.7). Or in other words, area of the square = a. a = a^2. Area of the rectangle of side a and b is ab. Area of the right triangle = !/2 ab, where a and b are consecutive sides of the rectangle; area of the Isosceles triangle = ½ of the square or rectangle, in which it is inscribed with one side being common and other two sides meeting the opposite side of the square or rectangle. Area of the Isosceles trapezium = ½ c (a+b), where a , b are the parallel sides, and c is the height. The area of *Mahavedi* (isosceles trap: face 24 *padas*, base 30 *padas*,and height 36 *padas*) and the *Sautramaniki* vedi(face 8√3, base 10√3 and height 12√3) are correctly given as 972 and 324 sq. *padas* respectively (Bsl 3.12; Asl. 5.7 & 5.8).

The construction of the *Paitrki vedi* as mentioned in the *Satapatha Brahmana(xiii. 8. 1. 5)* is a square of 1 sq. purusa with its corners pointed towards the cardinal directions, i.e. east –west and north-south. It is referred to by Baudhayana(Bsl.3.11), and also by Katyayana (Ksl. 2.2) where the method of construction has appeared in detail. First a square ABCD(of area 2 sq. purusas) is the obtained with EW and NS as east-west and north-south line, then by joining the middle points E, W, S and N, the square Paitrki vedi(ESWN) is formed, which is half of area of the original square i.e 1 sq. purusa (Fig.1).

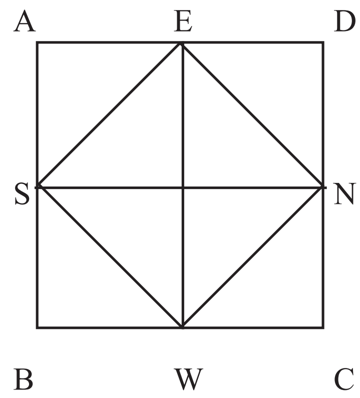


Fig.1: *Paitrki* square vedi (ESWN)

The bricks are often used as sq. units to measure the area of an altar. For falcon shaped fire altar, Baudhayana says, "187 ½ *pancami* bricks cover 7 ½ sq. *purusas*" (Bsl. 11. 2, 11. 3) which is correct since 187 ½ (1/5 x 1/5) = 7 ½ sq. *purusas*. Required number of 200 bricks were obtained by replacing a few pancami bricks with their half (*ardha*) or quarter (*padya*). The area of a circle to be πr^2 where $\pi = 3$, and also little better values, to be discussed later.

Baudhayana, Apastamba, Katyayana, possibly depending of the same analogy, gave $(1\frac{1}{2} a)^2 = 2\frac{1}{4} a^2$, $(\frac{1}{2} a)^2 = \frac{1}{4} a^2$, $(1/3\ a)^2 = 1/9\ a^2$, $(2\frac{1}{2} a)^2 = 6\frac{1}{4} a^2$, $(\sqrt{2}\ a)^2 = 2 a^2$, $(1/\sqrt{2}\ a)^2 = \frac{1}{2} a^2$ and so on.

4**. Numbers**

Integers: The number names consisted mainly of the following terms which may be divided into following three groups:

(i) *eka, dvi, tri, catur, panca, sat, sapta, asta, and nava*(1 to 9);

(ii) *dasa, vimsati, trimsat, catvarimsat, pancasat, sasti, saptati, asiti, navati* (!0 to 90, as multiples of 10); and

(iii) *sata, sahasra, ayuta, niyuta, prayuta, koti, arbuda, nyarbuda, samudra, madhya, anta, and parardha* (10^2 to 10^{12}).

For numbers below 100, compound words were used, e.g. *eka-dasa* (1 +10 = 11), *sapta-vimsati* (7 +20 = 27), *asta-trimsat* (8 + 30 = 38) etc were used. Subtraction principle were also followed, e.g. *ekanna-vimsati* (20 –1 = 19), *ekanna-trimsat* (30 – 1= 29) and so on. For numbers above 100, all the above three groups were used from higher to lower in order, e.g.

sapta satani vimsati (720), *sahasrani sata dasa* (1,110), *sastim sahasra navatim nava* (60,099) [RV.1.164.11; 2.1.8; 1.53.9 respectively]. This was an oral tradition and this shows that the numbers above 100 were expressed by three groups of scale beginning with *eka, dasa,* and *sata* in higher to lower order. There are also examples that the vedic scholrs could express numbers in series at certain intervals and even calculate the sum when they are in A. P.

Fraction: The technical terms for fraction : *ardhastama* = 7 ½ (Bsl.5.1, 5.6) ; *ardhanavama* = 8 ½ (Bsl. 5.1); *ardhadasama* = 9 ½ (Bsl.5.1) and so on were used. The word , *caturbhagona* = 1 – 1/ 4 = 3/ 4 had also occurred (Bsl.1.5).

Irrational Number : For irrational numbers, technical terms like *dvi-karani* = $\sqrt{2}$, *dvitiya-karani* = 1/ $\sqrt{2}$, *tr-karani* = $\sqrt{3}$, *trtiya-karani* = 1/ $\sqrt{3}$, *panca-karani* = $\sqrt{5}$, *pancama-karani* = 1 / $\sqrt{5}$ were commonly used. The word *savisesa* also indicated dvikarani = $\sqrt{2}$ from time to time. Apastamba used , *caturtha-savisesa* = ¼$\sqrt{2}$, *caturtha-savisesardha* = ½(1/4$\sqrt{2}$), *caturtha-savisesa saptama* = 1/7 (1/4 $\sqrt{2}$), and so on.

Square and cube Numbers: It has already been discussed that square of integers, fraction or rational and irrational numbers were known, though units were not specifically mentioned. It is not clear whether the significance of cubic numbers i.e. a.a.a = a^3 were known or not.

5. Geometry

The altar –makers arranged bricks on a specific area having a specified shape on a smooth plane surface. Leveling of the place was done very carefully and then tested by pouring water at the center , so that it could stretch uniformly. The *nitya- citis* had to be constructed on an area of one sq, *vyayama*, though their shapes are at times square or circle (for *Garhapatya agni*), square or rectangle (for *Ahavaniya*), and semi-circle (for *Daksinagni*). Obviously question arises how to construct a square, rectangle, circle or a semi-circle of the same size? Likewise, the *kamya-citis* covered an area of 7 ½ sq. *purusas* in the shape of isosceles trapezium, rhombus, triangle, circle, and in the shape of specified birds. How to construct these figures, or transform one figure to another having the same area. The transformation of square to a circleor circle into square having the same area again leads to the quadrature problem which fixes the value of π . This also necessitated the construction of a square equal to the sum or difference of two squares, establishing the theorem of square on the diagonal of a right triangle and various other properties including calculation of areas of these figures.

For construction of these figures on the ground, some instruments like pencil and compasses were needed. The *sulbakaras* usually used pointed poles, one (*eka-rajjuvidhi*) or two pieces of cords(*dvi-rajjuvidhi*) with loops at one or both ends, and colours or chalks for markings. All these ceremonies were solemnized with great austerity, and every care was taken with great professionalism, since it was ordained in the presence of important personalities, kings, besides hotas, adhyarvajus, and the public and for a specific purpose attaching a great social value. Another interesting feature was that all the altars were directed towards East, and there were elaborate arrangements to fix up the east-west line (*praci*), north-south line (*parsvamani*) which is perpendicular to east-west line. The *praci* and *parsvamani* of all vedis were drawn parallel to the main *praci* and *parsvamani* of the *Mahavedi* respectively in a major construction. How to construct these east-west and north-south lines. In addition, the diagonal of a square or rectangle were measured by cord (*rajju*) and it was known as *aksnaya-rajju*. While giving details of these construction, the Sulbakaras use the words, vijnayate (known as per tradition), vedervijnayate (known as per vedic tradition) very often (Bsl.3.1, 3. 9, 3.11, 4.3, 6.6, 7.4, 8.3,8.6, 16.1, 17.1, 19.1, 20.1,21.10, 21.11; Asl.5.1, 5.8, 6.1, 6. 3, 6.11, 7.1, 7.2, 7.3, 8.7, 11.1, 12.7, 12.9, etc and so on). A few details of geometrical construction will be of interest:

5.1. Construction of east-west and north-south lines

The reference of east-west(*praci*) and north-south (*parsvamani* or *udici*) lines are found mentioned in the *Satapatha Brahmana* in connection to the construction of *Mahavedi*. The Sulbasutras of Baudhayana, Apastamba, Katyayana and Manava have given great importance to these lines for construction of altars. The *Katyayana Sulbasutra* (Ksl. 1.2) describes as follows:

"Having put a pole on a level ground and described a circle round it by means of a cord (fastened to the pole) , a pole is fixed on each of the two points where the end of the pole's shadow(at sun-rise and sun-set moments on equinoxial day) touches (the two halves of the circle). The (line joining the two points) is the east-west line(*praci*). Then after doubling(a given) cord, two loops (made at its two ends) are fixed at the two poles (of the *praci*), and (the cord is stretched towards south by its middle point where) a pole is fixed; the same is repeated to the north. The line (joining the two poles is the north-south line (*udici*)".

This is evident from the following diagram(Fig.2):

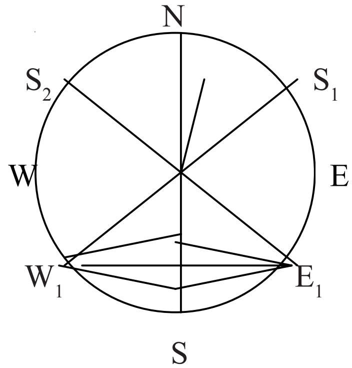


Fig. 2

In the Fig. 2, S_1, S_2 are the sunrise and sunset points, E_1, W_1 are the corresponding shadows. With the help of loops at E_1 and W_1 , direction N and S were found by the middle point of the cord which indicates north-south line. On equinoxial day when the day and night are equal, EW fixes the east-west line. The *Satapatha Brahmana* reports that Krttika never deviated from the east. At present , Krttika does not appear to rise exactly in the east but at a point north of east. Apte feels that the east point was verified by the rising point of Krttika in the vedic period. However the main praci line was found in the Siddhantic period by the equatorial line which passed through Lanka where the pole-shadow at midday is nil

5.2. Construction of a square, rectangle , isosceles trapezium

Square: Baudhayana has given three different methods of construction of a square(*samacaturasra*). Apastamba repeated two of Baudhayana's methods (Asl. 1.2 1.3) and gave three other new methods. These methods of construction have followed *ekarajju vidhi* (one cord system) i.e. carried out by one cord only.

For first method (Bsl.1.4), Baudhayana has prescribed that a cord of specified measure is to be taken with loops at both ends, and a mark at its middle. It is stretched along east-west lines and the poles are fixed. A circle is drawn by fixing both the loops at the middle pole and stretching it by its middle point to touch east and west points. Two circles are then drawn fixing one loop at east and west points separately and stretching it by the other end. The intersections of both these bigger circles give the north-south direction, with marks at the north and south points in the inner circle. Corner points of the square are found by drawing arcs by the middle mark of the cord when both the loops are fixed at east, north, west and south points separately. This undoubtedly is a traditional method and may be found in Fig. 2..

The second method of Baudhayana (Bsl.1.5) has taken a cord of measure a, increased it by the same measure and given loops at both ends of the extended cord 2a. Then a mark is given (*nyancana* mark) at ¼ a of the increased portion, making it a + ¼ a = 5/4 a, and the remaining part being ¾ a .Two end loops are again fastened to the poles fixed at east and west points measuring a, and the cord is stretched by the *nayancana* mark which makes a right triangle, since $\mathbf{a^2 + (\frac{1}{4} a)^2 = (5/4\ a)^2}$. Then the marks are given by the *nyancana* points after repeating the right triangles on both sides of the east-west line which gives the soulder (*amsa*) points. Then the half of the original cords from east pole stretched over *amsa* points fix the corner points of the square in the east side. The same is repeated in the west to get other two points. These corner points fix the square.

The third method of Baudhayana (Bsl.1.8) takes a cord of measure a, gives a *nyancana* mark at 13/12 a, the remaining part being 5/12 a, which makes uses of $\mathbf{a^2 + (5/12\ a)^2 = (13/12 a)^2}$ to form right triangle for construction of the square.

Baudhayana's second and third methods are repeated by Apastamba (Asl.1.2 and 1.3) . In Asl. 1.7 Apastamba gives a traditional method of construction by stretching by the middle points. Baudhayana(Bsl.1.9-1.11)followed by Apastamba(Asl. 2.1) gives method of using right-triangles, $\mathbf{a^2 + a^2 = (\sqrt{2}\ a)^2}$ **and** $\mathbf{1^2 + (\sqrt{2}\ a)^2 = (\sqrt{3}\ a)^2}$. For *Paitrki vedi* (square of side 5 *aratnis*), *Uttara vedi* (square of 10 *padas*), Apastamba(Asl 6.7 and 6.8) used the right triangles: $\mathbf{5^2 + (2\ 1/12)^2 = (5\ 5/12)^2}$ and $\mathbf{(10)^2 + (4\ 1/6)^2 = (10\ 5/6)^2}$ respectively.

Rectangle(dirgha-caturasra) and Isosceles trapezium (mahavedi) : Baudhayana (Bsl.1.6) gives a traditional method. He takes a cord of given measure, gives a mark at the middle. Pulling by the middle mark, different other marks are given following the method as before. Apastamba (Asl.7.1) took a cord and gave marks to form the right triangle $\mathbf{27^2 + (11\ \frac{1}{4})^2 = (29\ \frac{1}{4})^2}$, and used it for the construction of rectangle : 27 *aratnis* x 9 *aratnis*. For construction of another rectangle, Apastamba(Asl.7.2) used the cord forming the right triangle $\mathbf{18^2 + (7\ \frac{1}{2})^2 = (19\ \frac{1}{2})^2}$.

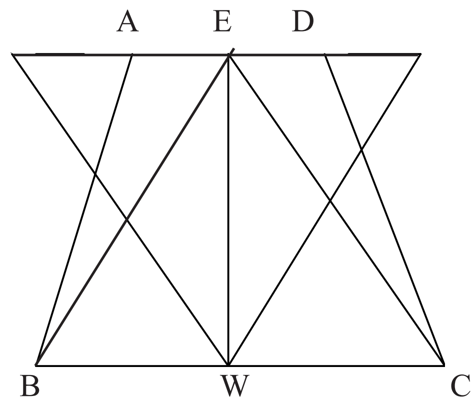


Fig.3.*Mahavedi*

5.3. Combination of two squares(s*amasa*): Baudhayana (Bsl. 2.1) says,

"If it is desired to combine two squares of different measures, a (rectangular) part is cut off from the larger (square) with the side of the smaller; the diagonal of the cut-off (rectangular) part is the side of the combined square". Apastamba repeats this method in Asl. 2.4. This is clear from Fig.4(a) and 4(b).

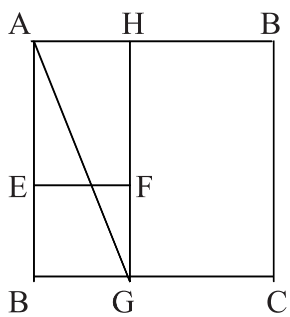


Fig.4(a)

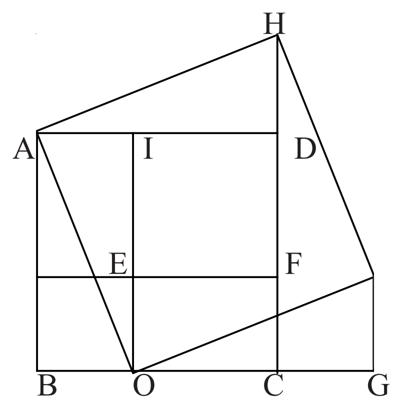


Fig.4(b)

This is obvious since $\mathbf{AB^2 + BG^2 = AG^2}$ in Fig.4(a). In Fig. 4(b) likewise, AB^2 and EC^2 together contains four right triangles and a square, the same may be found in AO^2. Hence AG or AO determine the addition (Samasa) of two different squares.

5.4. Difference between two squares (nirhasa): Baudhayana (Bsl. 2.2) says,

“ If it is desired to remove a square from another, a (rectangular) part is cut off from the larger (square) with side of the smaller one to be removed; the (longer) side of the cut off (rectangular) part is placed across so as to touch the opposite side; by this contact (side) is cut off. With the cut-off (part) the difference (of the two squares) is obtained”. Both Apastamba(Asl.2.5) and Katyayana (Ksl. 3.1) repeat the same method . This is clear from Fig.5(a) and 5(b).

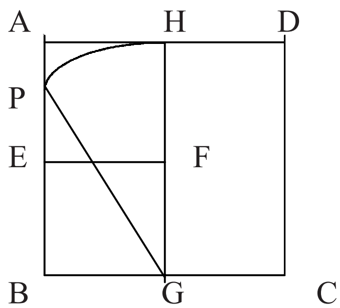


Fig.5(a)

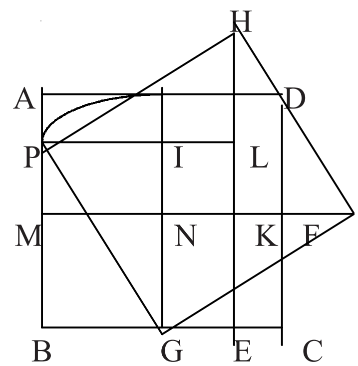


Fig.5(b)

This is obvious since $\mathbf{PB^2 = PG^2 - BG^2 = AB^2 - BG^2}$ in Fig 5(a). From 5(b), PG^2 has four similar triangles of the type PBG and a square INKL. Two similar triangles form the rectangle PBGI . The other two similar triangles form the rectangle MBEK which is equal to MB^2 and the rectangle NGEK. Joining together we get the PB^2 and the MB^2.

5.5. Transformation of a square or rectangle into isosceles trapezium, triangle and rhombus

Square or rectangle into isosceles trapezium : The method of transformation square(*caturasra*) to isosceles trapezium(*mahavedi*) has first appeared in the *Satapatha Brahmana*(10.2.1.4). It is also given by Baudhayana(Bsl.2.6) which is clear from Fig. 6.

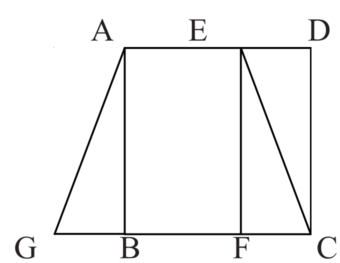


Fig. 6

ABCD is the given square. AE is cut off as per measure of the shorter side of the required trapezium. The rectangular portion EFCD is by the diagonal and placed on the two sides as shown. The similar method is also followed for transformation of rectangle.

Square or rectangle into isosceles triangle or rhombus: From square(*caturasra*) to isosceles-triangle(*mahavedi*) having the same size, Baudhayana (2.7) says that from the given square, a square is to be constructed whose area is double the given square. Then the middle point of one side is joined with two opposite corner points,. The triangle formed is equal in area of the given square (Fig.7). From rectangle to triangle, first a rectangle having double area of the given rectangle is constructed , then changed into square as per method (Bsl.2.5) . For transformation of rectangle to rhombus, a rectangle of double the given size is constructed as shown (Fig 8), then the rhombus is formed by joining the opposite middle points.

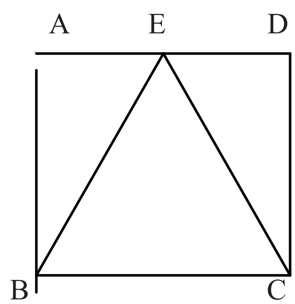


Fig. 7

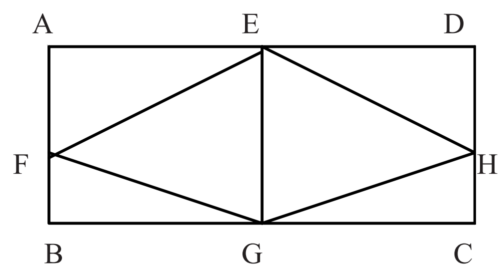


Fig. 8

6. Construction of Trapezium by two cords(dvirajjuvidhi)

The construction of square, rectangle, triangle were usually done with one piece of cord and marks were given which satisfy right-angled triangle. Two pieces of cords with given marks satisfying two right-angled triangles were also used for the construction of trapezium. Justification as to how to obtain such relations are given by Apastamba (Asl.5.3 – 5.5) :

I. From relation $3^2 + 4^2 = 5^2$, the other relations obtained are:

(i) $(3 + 3.\ 3)^2 + (4 + 3.\ 4)^2 = (5 + 3.\ 5)^2$ i.e. $12^2 + 16^2 = 20^2$;

(ii) $(3 + 4.\ 3)^2 + (4 + 4.\ 4)^2 = (5 + 4.\ 5)^2$ i.e. $15^2 + 20^2 = 25^2$;

This shows that an attempt was made to establish a more general formula:

$(3 + 3n)^2 + (4 + 4n)^2 = (5 + 5n)^2$ i.e. $[3(n+1)]^2 + [4(n+1)]^2 = [5(n+1)]^2$, when n = 1, 2, 3..so on.

I. From the relation $5^2 + 12^2 = 13^2$, the relation likewise were obtained as

$[5(n+1)]^2 + [12(n+1)]^2 = [13(n+1)]^2$, when n = 1, 2, 3..so on.

7. Value of π

Square to circle : (i) Baudhayana (Bsl.4.15) suggests **π = circumference:diameter= 3.** (ii) Baudhayana (Bsl.2.9), Apastamba (Asl.3.2),and Katyayana (Ksl.3.11) prescribe more or less the same method for transformation of the square into a circle in which it is suggested that a cord of half the length of the diagonal of the square is stretched from the center to the east; one-third of the part lying outside is added to the remainder, which gives the radius of the circle.

This gives r = a + !/3 (√2 a – a)= a(2+√2)/ 3 , where 2a = side of the square, and r= radius of the transformed circle. **Since the area is same, $\pi = 4a^2/r^2 = 3.0883$** ,

where √2 = 577/408 (Bsl.2.112; Asl.1.6; Ksl.2.9).

Circle to square:(i) Baudhayana (Bsl. 2.10; see alsoBsl. 4.15) gives a more refined value when a circle is transformed into a square. He gives **the side of the square** = (1 – 1/8 +1/8.29 – 1/8.29.6 + 1/8.29.6.8) d =**(9785/ 11136). 2r**. Obviously area of the transformed square = $4\,(9785/11136)^2 .\, r^2$; Area of the circle = πr^2 which gives,

$\pi = 4\,(9785 / 11136)^2 = 3.0885$, the correct value being 1.1415 6. Thibaut and Cantor believe that the value is obtained from r = (2 + √2)/3 = (2 + 577/ 408)/3=1393/1224 , for 7/8 of1393= 1218 7/8, 1/ 8.29 of 1393=6 1/ 232, 1/ 8.29.6 of 1393= 1 and 1/8.29.6.8 = 1/8, which gives the total 1224 1/232, an excess of 1/232 . But the result obtained in a process of conversion from square to a circle is quite commendable.

(ii) Baudhayana (Bsl.2.11) also gives a rough value of π while transforming a circle likewise into square, where **$\pi = 4(1 - 2/15)^2 = 3.004$**.

8.Value of √2

Baudhayana (Bsl.2.12), Apastamba(Asl.1.6) and Katyayana(Ksl. 2.9) give the same value of √2 which state :

pramanam trtiyena vardhayet tat ca caturthena atmacatustimsanena savisesa / sa dvikarani /

"The measure is to be increased by its third and (third) again by its own fourth less the thirty-fourth part (of that fourth; this is(the value of) the diagonal of a square (whose side is the measure)".

In other words, $\sqrt{2} = 1 + 1/3 + 1/3.4 - 1/3.4.34$ (approx.)= 577/408(approx) =1.4142156 (modern value=1.4142135), which is correct to five places of decimals.

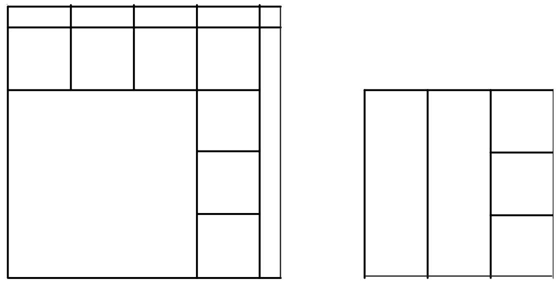
It further says that it is an approximate value (*savisesa*). This marks a tremendous achievement about 2500 years before the present time. Datta has justified that that the upasarga *vi* prefixed to a word *sesa* always indicates a special significance which is approximate. How was the sulbakaras arrived at this value, that to approximate, is indeed a puzzle.

There are large number of suggestions as to the methodology of calculating the value by G.Thibaut(1875), Rodet(1879), Datta (1932) and others. Thibaut suggested that since $!7^2 + 1 = 2.\ 12^2$. There might be an attempt to diminish some portion from the side of square 17 to make it equal to 2.12^2. This leads to $2x\ 17 \times 1/34 = 1$, which was equated to $(17 - 1/34)^2 = 2.\ 12^2$. This gives $\sqrt{2} = 17/12 - 1/12.\ 34 = (12 + 4 + 1)/12 - 1/3.4.34 = 1 + 1/3 + 1/3.4 - 1/3.4.34$.

Rodet suggested that a fourth-term approximation of the following type might have been known :

$\sqrt{[a^2 + r]} = a + r/(2a + 1) + (r / 2a + 1)\ [1 - r/(2a + 1)] / 2[1 + r/(2a + 1)] + \varepsilon$, where ε = fourth approx. For $\sqrt{2}$, first term = 1, 2^{nd}= 1/3, 3^{rd}= 1/3.4, and 4^{th} = - 1/3.4.34.

Datta gives a geometrical demonstration following sulba tradition which is similar to Thibaut but a much plausible and improved method. He says (pp.192-94) that for combining two squares having unit length each, the second one is divided into three equal rectangular strips, two rectangular strips are placed on two sides of the first square(Fig.9). The third rectangular strip is again divided into three equal squares and one square is placed in the hole created in the first square . This gives the side of the first square as 1 + 1/3.



I II

Fig.9

The remaining two small squares of third rectangular strip is divided into four rectangular strips and are placed on the sides of the first square as shown. Then side of the first square is increased to 1 + 1/3 + 1/3.4 i.e. 17/ 3.4, taking into consideration the small square hole at the corner of side 1/ 3.4 unit, which is in excess. To neutralize , two equal strips of breath say x and length 17/ 3.4 have to be deducted , which is roughly equal to $(1 / 3.4)^2$. This gives x = $(1 / 3.4)^2$/ 2. (17/3. 4) = 1 / 3.4. 34 . So the side of the combined square $\sqrt{2}$ = 1 + 1 / 3 + 1/ 3. 4 – 1/ 3. 4. 34. This again leaves a smaller hole at the corner, which makes the result approximate.

A small cuneiform tablet of the Yale Babylonian collection (No.7289) gives three numbers in sexagesimal unit in c.1500 BC, which according to Neugebauer satisfies the relation d =$\sqrt{2}$a fixing the value of $\sqrt{2}$ = 1,24,51,10 = 1.41421291 (correct to five decimals). Both Indian and Babylonian value are correct to five places, but the former is smaller and the latter is larger than the correct value. The Indian tradition of altar construction is very clear and seems to be original, which is undoubtedly a unique contribution in the field of mathematics.

9. Theorem of Square on the Diagonal

Baudhayana states that in a rectangle ABCD, $AC^2= AB^2 + BC^2$. He states as follows(Bsl.1.12) :

dirghacaturasrasya aksnayarajjuh parsvamani tiryanmani ca yat prthakbhute kuruta stad ubhayam karoti /

"The diagonal (aksnaya rajju) of a rectangle produces the same area which its perpendicular (parsvamani) and base(tiryanmani) produce it two together". This is a general statement of the ' Theorem of the square on the diagonal of a right-angled triangle'. The proposition is stated almost in identical language by Apastamba(Asl.1.4; Ksl.2.7; Msl.10.10). Baudhayana further says (Bsl.1.13) that 'the theorem is easily verified from the triplets: 3^2

$+ 4^2 = 5^2$, $5^2 + 12^2 = 13^2$, $7^2 + 24^2 = 25^2$, $8^2 + 15^2 = 17^2$, $12^2 + 35^2 = 37^2$, $15^2 + 36^2 = 39^2$.'

Indian sulbakaras did not furnish any proof since this is beyond their tradition. A host of foreign scholars like Zeuthen, Cantor, Vogt, Cajori and Heath have expressed the view that the general statement was possibly the result of an induction from a small number of cases of right-angled triangles having sides in rational number known to them. But this is not the case. Our basis for not accepting the argument may be summarized as follows:

(i) For construction of the Paitrki vedi (Fig.1), the theorem is obvious from the construction $SE^2 = AE^2 + AS^2$ since SE^2 contains four isosceles triangles, AE^2 and AS^2 contain two isosceles triangles each of the same type. The combination of two different squares(Fig.5.3) described by Baudhayana is another case which might have laid the foundation.

(ii) Sulbakaras have established the identities like, $[3(n + 1)]^2 + [4(n+1)]^2 = [5(n+1)]^2$,when n= 0,1,2.. (vide Item 6). It is not unlikely that they might have established generalization of the following types: $(2n+1)^2 + [2n(n+1)]^2 = [2n(n+1) + 1]^2$ or $(2.2n)^2 + [(2n-1)(2n + 1)]^2 = [(2n-1)(2n +1) +2]^2$ for n=1, 2,3 …...and so on.

(iii) Baudhayana(Bsl.1.9-1.10) states : *samacaturasrasya aksnayarajjuh dvistavatim bhumim karoti , pramanam tiryag dvikarani ayamah tasya aksnayarajjuh trkarani i.e.* 'The diagonal of a square (of unit area) produces double the area (of the square). The breadth (of a rectangle) being the side of a given square(pramana) and the length the side of a square twice as large (dvikarani),the diagonal produces the side of a square thrice as large(trkarani)'. In other words, $1^2 + 1^2 = (\sqrt{2})^2$, $1 + (\sqrt{2})^2 = (\sqrt{3})^2$.

The following diagrams (Fig.10 & Fig.11) drawn on the basis of the hints available in the Sulbasutras justify possibly the truth of the statement $1^2 + 1^2 = (\sqrt{2})^2$.

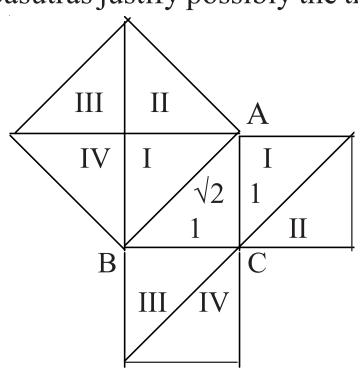


Fig.10(a)

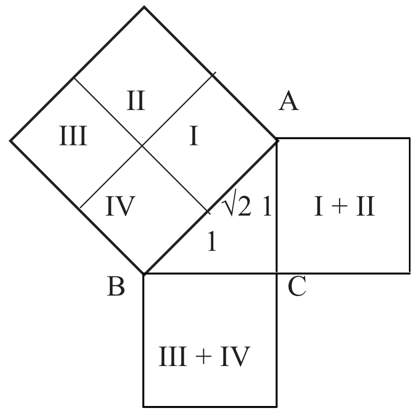


Fig.10(b)

Fig.10(a) shows that in a right triangle ABC, AB^2= I + II + III + IV, $AC^2 + BC^2$= I + II + III + IV. Hence $AB^2 = AC^2 + BC^2$. Similarly from Fig.10(b), AB^2= I + II + III + IV = $4 \times (\sqrt{2}/2)^2 = 2 = 1 + 1 = AC^2 + BC^2$.

The following diagram (Fig.11) will show how $\sqrt{3}$ was obtained from the relation1: $1^2 + (\sqrt{2})^2 = (\sqrt{3})^2$.

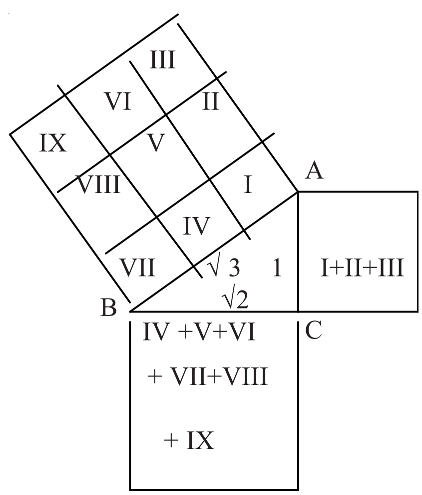


Fig . 11

In giving the justificatiom Baudhayana (Bsl.1.11) says how *trtiyakarani* was obtained by dividing square on the side $\sqrt{3}$ (*trkarani*) into nine divisions (*trtiyakarani etena vyakhyata / navamastubhumerbhago bhavatiti /*). Obviously the area of one smaller square on AB = $1/9 . (\sqrt{3})^2 = 1/3$. AC^2 = I + II + III = 3. 1/ 3 = 1 unit, BC^2 = IV + V + VI + VII + VIII + IX = 6 square units = 6 . 1/ 3 = 2 units , $AB^2 = (\sqrt{3})^2 = 3$ units. This proves the veracity of the general statement , $AB^2 = AC^2 + BC^2$.

In this context it will not be out of place to mention that Thibaut in 1876 and Burk in 1901 referred to the Sulbasutras containing the use of large number of triplets in connection with the construction of altars in the Sacred Book of the East. Neugebauer (1945) kept silent of the discovery of the Indians till he discovered a set of Babylonian triplets (BM 34568) dating approximately between 1900 BC to 1600 BC. The name of the Greek scholar Pythagoras (500 BC) is only associated with the triplet (3,4,5), which he might have got from the Babylonian. The Chinese also used the triplets (7,24,25) in *Chiu Chang Suan Shu* (50 BC to 100 AD). The Egyptian had also some knowledge of such tripletsin connection to rope-stretching required in the foundation ceremony of temples. No culture had such a long tradition as that of the Indians and the credit goes to Sulbakaras who discovered not only a large number of triplets having sides of right triangles both in rational and irrational numbers but also discovered the general statement of the theorem of square on the diagonal.

10. Concluding Remarks

In conclusion, I wish to point out that the Indian life during vedic times with all its social and political institutions has been under the influence of religion and bound by value system. The urge for finding right time and happiness through construction of nitya and kamya vedis for sacrifices gave the first impulse for astronomical observations and accurate mathematical and geometrical discoveries. Early vedic society was very vibrant and the vedic priests had discussed, absorbed or given out whatever knowledge was found relevant and important. This is attested by their discovery of the Indian measurement by chord, the value of $\sqrt{2}$, the theorem of square on the diagonal. Though the Indian methods differ distinctly from both Egyptian and Babylonian traditions, the possibility of contact and exchange cannot be ruled out distinctly. The Indian tradition went a long way with the Brahmins and Ksatrias who were mainly concerned with the spiritual activities and had the monopoly of higher branches of knowledge with the introduction of certain taboos, caste barrier and the system of social impurity etc. As a result, the prists who were the originators or promoters of long traditions themselves became the worst victims and missed cooperation from both common people and their own kins who were experts in their respective arts of science and technology. The same were found with the sulba traditions when we find only the commentators

Dvarakanatha (*Sulbamimamsa* on the Baudhayana), Kapardisvami, Karavindasvami and Sundararaja (on the *Apastambasulbasutra*) , Mahidhara (*Karkabhasya* on the *Katyayana sulbasutra*) from 9th AD on wards. Recently R.C.Gupta has brought to our notice a list of texts containing details of *agnikundas* at a later period which might be examined for possible successor of the wonderful tradition what we had during the vedic period.

Bibliography

Apastamba Sulbasutra with commentaries of Kapardisvamin, Karavinda and Sundararaja, ed. By D. Srinivasabhar and V.S. Narasimhachar, Mysore Sanskrit Series no.73, 1931.

Bag, A. K.,"The Knowledge of Geometrical Figures, Instruments and Units in the Sulbasutras", *East and West*, 21.1-2(1971)111-19.

Bag, A. K. , "Ritual Geometry in India and its Parallelism in Other Cultural Areas", *Indian Journal of History of Science*, 25.1-4 (1990) 4-19.

Burk, A.,"Apastamba Sulbasutra", ed.and pub. With notes and comments in *Zeitschrift d. deutsch morgenlandischen Gesellschaft*, 55(1901)543-91;56(1902)327-91.

Cantor, M.,*Vorlesungen uber die Geschichte der Mathematik*, 1, part 3(1907)636-95.

Datta, B., *The Science of Sulba*, Calcutta University, 1932.

Datta, B. "Vedic Mathe matics", The Cultural Heritage of India, Vol.6, pp.18-35, The Ramakrishna Mission Institute of Calcutta,Revised and Enlarged edition,1986.

Gupta, R.C.,"Baudhayana's Value of √2", *The Mathematics Education*, 6.3(1972)77-79.

Gupta, R.C., "Agni-kundas-A Neglected Area of Study in History of Ancient Indian Mathematics, *Indian Journal of History of Science*, 38.1 (2003) 1-16.

Gurjar, L.V.,"The Value of √2 given in the Sulbasutras", *Journal of the University of Bombay*, 10.5 (1942) 11-16.

Heath, T.L. *A Manual of Greek Mathematics, Dover Publication*, 1963.

Needham, J., *Science and Civilisation in China*, Vol.3 (Mathematics), Cambridge University Press, 1957.

Neugebauer, O. & Sachs, A., *Mathematical Cuneiform Texts*(American Oriental Series Vol.29), New Haven, p.41,1945.

Neugebauer,O.,*The Exact Sciences in Antiquity*, Copenhagen,1952.

Ramgopal, *India of Vedic Kalpasutras*, New Delhi, 1959.

Rodet, L., "Sur les methods d'approximation chez les anciens", *Bulletin Soc. Math. D. France*, 7 (1879) 159-67.

Sulbasutras of Baudhayana, Apastamba, Katyayana and Manava with Text, English tr. and Commentary by S,N.Sen and A.K.Bag, Indian National Science Academy,

New Delhi, 1983.

Thibaut, G.,"On the Sulbasutras", *Journal of the Asiatic Society of Bengal*, 44.3, part I (1875), 227-75.

Van der Waerden, B.L.,"On the Pre-Babylonian Mathematics I", *Archive for History of Exact Sciences*, 23 (1980)1-25.

Vogt,H.,"Der Pythagorische Lehrsatz im der altesten Geometrie der Inder", *Schlesische Gesellschaft*", 84.3 (1906.

Zeuthen, H.G.,"Sur l'Arithmetic Geometrique des Grecs et des Indiens", *Bibliotheca Mathematica*, Series 3,5 (1904)97-112.

Abbreviations :

Bsl- *Baudhayana Sulbasutra*, Asl- *Apastamba Sulbasutra*, Kath.S. – *Kathaka Samhita*, KPS – *Kathaka Kapisthala Samhita*, Ksl – *Katyayana Sulbasutra*, Mait.S. – *Maitrayani Samhita*, Msl – *Manava Sulbasutra*, RV- *Rg Veda*, SBr – *Satapatha Brahmana*, Tait.S. – *Taittiriya Samhita*, Vaj.S. – *Vajasaneyi Samhita* .

India's Contribution to World thought and Culture

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India through her long history has influenced the culture of most countries of Asia and the Western World.

Europe was aroused to the beauty of Sanskrit Literature by the English translation of ¹hakuntal¢ of K¢lid¢sa by Sir William Zones in 1789. Goethe, the German Poet dramatist, who is undoubtedly the greatest Literary figure in the Western World, expressed about Meghad¦ta and ¹hakuntal¢ of K¢lidas¢.

Pythagoras was highly influenced by Ved¢nta Philosophy of India. Theory of the transmigration of the soul from body to body. It is however, an established fact that this theory first appears in the Br¢h ï a´as and the upani¾ads. It is, therefore, most likely that Pythagoras was influenced by India rather that by Egypt. Almost all the theories religious, philosophical and mathematical thought by the pythagorous were known in Indian the 6th Century B.C.

Sanskrit Niti literature or wise sayings are so popular, also spread out to countries West, South and North.

So many Indological work were done by many European and American Scholars like Sir Charles Wilkins ; Sir William Zones, Sir Thomas Coolebrooke, Friedrick Ruckert, Eugene Burnous, Cumingham, Hermann Jacobi, and many others.

Sw¢m¤ Vivek¢nanda is the one person who stands as a golden link between India and the rest of the world, as well, Sw¢m¤ Vivek¢nanda took India out of her isolation of Centuries and brought her into the main stream of International life. Vivekananda said "Buddha has a message to the East and I have a message to the West. ''India's spiritualism and philosophy influenced Western mind. India contributes spirituality and philosophy to mankind. Vivekananda went America and stood for the unity of East and West. Vivek¢nanda said, India's contribution to the sum total of human knowledge has been spirituality and philosophy, Vivek¢nanda, however, knew that the western civilization will not survive if, it does not provide the foundation of spiritualism. ''Be Free'' the great message of Swamiji. He said, ''Western World is torn in wars and has fallen in Human valves. The west needs the rational strength of Ved¢nta.

Sw¢m¤ Vivek¢nanda brings one among the many, who carried India's thought outside world in various fields temporal as well as spiritual since the dawn of history.

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Ancient Lapidary Techniques in Cambay, India

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Of all the ornamental beads the toughest materials to process are those of stones, particularly the crypto-crystalline/microcrystalline silica and jade. Lapidaries in the ancient India had mastered the techniques of colour enhancing, cutting (shaping and grinding), polishing and perforating stones beads as evidenced by the stone beads of carnelian and other silica varieties obtained from the excavations pertaining to Indus Valley Civilization. Occurrence of rough (unprocessed) stones and stones under various stages of processing in the excavated sites indicate that they were locally processed. Different stages of lapidary processes can be interpreted by a keen observation of the technology employed in the contemporary bead industry in Cambay (Khambhat), in Gujarat that happens to be the oldest surviving gem industry in the world. Particularly the study of techniques adapted before the introduction of electricity (mid-twentieth century) to manufacture beads indicates that many of the steps were comparable with the ancient processes. Most rough materials used, tools employed, and products including partially processed beads and waste materials of cutting have striking similarities. Although recently there is a drastic improvement in the processing of stone beads in Cambay owing to mechanisation, even today some of the ancient steps of cutting are retained. These steps are enhancing the colour of stones by heating and other treatments, shaping by chipping and perforation using bow-drill.

Colour enhancing techniques such as heating pebbles of chalcedonic silica with greyish white to yellow tints in reducing atmosphere and boiling chalcedonic varieties in sugar-solution/honey coupled with acid treatment to produce black-brown onyx practised in olden days are still being continued. Another technique unique of Cambay is shaping hard extremely tough microcrystalline silica as well as crystalline silica and other stones by chipping using buffalo horn-head hammer. The *chipped-out* stone splinters are comparable to the splinters obtained from Harappan excavated sites. The most exciting contribution of the ingenious lapidary of Cambay is perforating stone beads using bow-drill fitted with diamond bits. While single diamond-tipped drill shaft is employed for marking the spot for perforation, double diamond-tipped drill shaft is taken for full-length perforation. The full-length perforation is achieved by drilling from both ends that meet at the centre. Powder of silica beads obtained as a by-product of bow drilling is used as a very effective polishing agent to polish even harder ruby, sapphire and emerald. This is another remarkable contribution of the artisans of Cambay. Until the last quarter of the Twentieth Century this technique of perforation was employed profusely. However, at the turn of the last millennium modern method of perforation using ultrasonic drilling units have hurriedly replaced bow-drills. At present there are only a very few skilful artisans left who occasionally adapt this technique to perforate long beads of over two centimetre dimension.

There are also a few other innovative lapidary techniques worth mentioning such as cutting and polishing bowls and shaping spherical beads that are typical of this gem-cutting centre.

• • •

On Language : A comparison of Bhartrhari and Saussure

Ranuka Ozarkar
Mumbai

In classical Indian tradition, grammarians like Panini and philosophers of six major schools studied language. These two traditions representing different viewpoints were integrated by Bhartrhari (5th century A.D.), the author of *Vakyapadiya* . Bhartrhari's grammar of language has firm basis in his *Vedantic* philosophical background. He looks at language as a tool of cognition as well as that of communication.

In modern times, Ferdinand de Saussure (1857-1913), father of modern linguistics and semiology, looked at language as a system of signs. A linguistic sign is an associative whole of sound image and concept it stands for. Besides, by anticipating a place for semiology, he integrated linguistics and social sciences like philosophy, poetics and Psychology.

One finds striking similarities between Saussure's theory of language and Bhartrhari's views on language which I wish to describe through this paper. Comparison will be drawn regarding the following:

1. *Sphotavada* and Saussure's notion of 'linguistic sign'
2. *Nityasambandha* and the association of the sound and meaning in a 'sign'.
3. Four phases of speech and Saussure's distinction of language system and language use
4. *Shabda-brahman* and Saussure's holistic approach

It should be noted that the concepts of both the scholars are 'comparable' and not identical.

These similarities have drawn attention of the modern linguists to Bhartrhari (e.g. Ashok Kelkar, Lacchman Khubchandani, Kapil Kapoor). In the current times, when the social scientists (Dell Hymes, Austin, Searle, Khubchandani, Kapoor, Pierce) have been concerned with cognition and communication through language, Bhartrhari's views on language can provide useful insights in this enquiry.

In the light, there is a need to revisit Bhartrhari and locate his theory in the schema of the modern enquiries. Such a comparison can be a starting point of further studies in this regard.

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Earliest Vedic calendar and its evolution through the ages

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It is pointed out that the earliest Vedic calendar had a Ritusamvatsara (year of seasons) containing 360 days. It was started at winter solstice (22 Dec. in Grogorian calendar) heralded by the heliacal rising of Ashwini nakshatra around 7000 BC. The calendar was controlled by a year long Gavamayanam sacrifice of 360 days followed by 4 to 6 days of Pravargya and Upasad days of consecration to complete the year. Later on it was converted into a six year yuga made of 6 years of 360 days followed by an adhikamasa of 30 days. The practice of starting the year at winter solstice continued throughout the Vedic period by shifting the year beginning caused by the phenomenon of ayanachalan.

Around 6000 BC when the length of the lunar month was fixed at $29^{1}/_{2}$ day's Gavamayanam sacrifice was replaced by the Utsarjinamayanam sacrifice lasting 12 lunar months followed by 11 atiratra days, for completing the year. And the six year yuga system was continued. As this involved a change in the lunar tithi (30^{th} part of the lunar month) at the beginning of each year Utsarjinamayanam was replaced by the 5 year yuga system around 4000 BC, in which two lunar adhikamasa were added in 5 years of 12 lunar months so that the year always started on the first tithi of the month.

The 5-year yuga was not accurate as it had 366 days in a year instead of 365.25 days. This amounted to 15 tithis extra in 15 years. So the year was a tuned to seasons by dropping one paksha (half month) after every 15 years giving rise to Dakshajaniya sacrificial system of 30 years. Later on around 3000 BC for convenience a full month was dropped as kshayamasa after every 30 years. A final correction was applied by 95-year Agnichayana Vidhi in which 3 Dakshaniya sacrifices were followed by an ordinary 5-year yuga.

The mathematical rules for the above lunisolar calendar were formulated by Sage Lagadha around 1400, who also gave the procedure for correcting the approximate calculations. Vedang Jyotish type calendar continued to be used by the Jain astronomers of 500 BC and is found in the Vashistha Siddhanta mentioned in Vrrahamihir's Pnchasiddantika of 500 AD

But there occurred a break in tradition around the beginning Christian/Saka Eras due to Babylonian and Greek influences. The main difference was the change in the year beginning from winter solstice to the sixed vernal equinox (21 March in Grogorian calendar) of 285 AD. Thus the calendar became sidereal (nakshatra varsha) instead of ritusamvatsara. It has a fool proof method of introducing adhikamasas for making sidereal luni-solar adjustment, but it is being divorced from seasons by one day in 72 years and the difference has grown to 24 days in the last 1700 years. So the main purpose of adjusting the social functions like agriculture according to season is slowly being eroded. This is not a plea to change our calendar but to make the people aware that the beleifs like 'Mkarasankranti represents the beginning of uttarayan' are wrong, because uttarayana starts on 22 Dec. and not on Jan 14 or 15.

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A Unique Indian contribution to Liguistics

Rajagopal S. Iyer
Thane

Apart from the praatishaakhya-s and shiikshaa which are definitive phonetic guides, the very process of vikR^iti paaTha is interesting in the sense that it has helped preserve the oral tradition for many millenia. This paper purports to look into the some of the details of the vikR^iti paatha associated with taittiriiya yajur veda and discusses its relevence to Speech recognition technology, an area of research in computer technology.

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Concept Of Mind in the Indian Context

Ms. Deepali C. Marathe

Every human being has mind and this has been accepted by all.Though it forms part of the body it can not be shown.Medical science knows every part of the body and after dissection can ever show each one to anyone.However Mind is an exception to this.Though it can not be shown or seen,its existence has been accepted by all today.

In western world,mind was taken for a detailed studyonly 200 years ago whereas in India Mind is being studied from vedic times,which dates back to 4500 BC.Indian contribution to world civilization in concept of MIND is considerd with following points :

1. First refrence of mind in Rigveda.
2. Search of mind continued.
3. Mind continued its march in literature.
4. In saints' literature with special reference to Ramdas.
5. Place of mind in the body.
6. Mind and sense organs.
7. Importance of mind in Yoga Sootra of Patanjali (300 BC).
8. Basic principle of Ayurveda.
9. Western people demand for thoughts from Ayurveda which had its roots with study of mind.
10. WHO
11. Medical History Search
12. Psychology - Mind in Psychology
13. Effective ways to conquor the mind.
14. Conclusion.

• • •

Ophthalmic excellence of ancient India - myth or reality?

Dr. Vijaya J. Deshpande
Pune

Time and again one comes across articles that narrate ophthalmology and cataract surgery as described in *Susrutasamhita.* They have an undercurrent of a claim to preeminence of ancient India in the field of ophthalmology and to the path-breaking procedure of couching. India did have a long tradition of ophthalmic study and practice starting from the legendary Nimi through Susruta and Nagarjuna of the second to fourth century AD to Vagbhata of the sixth century AD. Moreover, transmission of ophthalmic knowledge to China was brought to notice with the unveiling of three historical Chinese ophthalmic works by the twentieth century Sinologists. Out of these three works two are attributed to Nagarjuna and the third points to India as its source. Study of these works reveal a marked similarity with ancient Indian ophthalmology in number of aspects viz. etiology, nosology, medicinal preparations as well as surgical procedures. None of these three works is a translation of any ancient Indian medical work though. They nonetheless depict an integration of the two medical systems.

It is a well-known fact that the eighth century AD Arabic works referred to Indian medical men like Caraka and Susruta. Scholars have been aware of similarities in ancient Greek and Indian medicine for some time now. Exact nature of these ancient exchanges is not known. Likewise there are parallels between accounts of cataract surgery in Greek/Roman, Arabic and Indian works. They hint at a possibility of transmission, yet there is no conclusive evidence to pinpoint the source one way or another. As in the case of ophthalmology and cataract surgery, there are suggestions to number of medical exchanges between distant cultures. Till concrete data comes up one is uncertain about their nature and direction. While origin of cataract surgery remains a mystery, Indian ophthalmic expertise at the time of compilation of *Uttaratantra* part of *Susrutasamhita* and its eastward transmission to China is a well-documented historical reality. The transmitted material further formed a basis for later ophthalmic development in China and was a major contributor to it from Tang times onwards.

• • •

Monier William's great Contribution towards World Civilisation (through Indian connection)

S. K. Sharma
Parwanoo, H.P.

The very fact of âgveda having been translated into English by H.H. Willson and Atharvaveda by W. D. Whitney and Yajniveda and Atharveda translated by Grijist¤, ¹atapaths Brahmaés by Eggling and A. A. Maldcnell's great contribution by prefer a Vedic Dictionary and a grammar, Vedic Reader, Whitney's Vedic Grammar, and Caland and other Western Scholars editing this tests of ¹iékhayan ¹rauth ¹utra, Mouser William English Sanskrit Dictionary and Sanskrit English Dictionary all go to prove the Subtle predication of World Scholars working on various aspects of Vedic Literature. Sternback's compare in ''Annat India"- M. Stein's Text of Nojatarangini F.W. Thomas and E.B. Cowell's translating of Harsalavta and Sir luo Rocha's Cuticls on "¹¢hasa" interpreted as "Pecumay Fine etc. equally pourt to the contribution of world scholars towards Indian civilization in this article ''Cambodian in Insluptures'' differed by a scholar Cleculy indicated this impact of Indian civilization by contribution beyond India. Dr. B. Ch. Chobra's explosion on 'Hawrt' Islands preserving this jossils and symbols proving the existence of Vedic cultural in that ana in Ancient times. The Sanskrit, English Dictionary of Mouser Willam's preservers all the fundamental basic phonology and Morphology which clearly indicates that Sanskrit in original faced this light rank of Ancient Indian and world civilisation.

• • •

Vemana : Contribution to the World of Science

Prof. Tara Prasad Das
Ph.D (Paris 1945)
Prof. Emiritous CIEFL, Hyderabad

Dr. Mallikarjuna Reddy
Ph.D, Research Scholar
Osmania University, Hyderabad

Introduction

I plan this study to introduce you sir as I have studied for PhD thesis ie the Historical perspective about Vemana and Vemana verses came into published form by the scholars and of which (63**) Sixty three aspects** Telugu peoples life dealt during Vemana period(1650 to 1750 AD While tukish ruled ouer Andhra pradesh)

Vemana verse dealt on **various aspects of Peoples life** :

Rational, Moral, On woman, Mother, wife, Sexuality, Fun, Happiness -10

Desire, Philosophy Yogic, devotion, Liberation, Equality,

Truth Family, Relations, Superstutions, Evils -20

Teacher, Education, Renounce, Metal, Reddy, Poets,

Knowledge and wisdom, Criticising of things, Nature Humorous -30

Food, Toddy, Life, Turks, Vaishyas, Castes, Anger,

Sin, Posessin, King, God -40

Religion, Bramins, Humanity and men, Infactuation, Donation, Inscription, -50

Elders, Lingayats, Hunting, Water Greatness, Poor and Ignorant, Sudras Bravery, Farmers, Vehicle and transport, Friend, Jeolosy, Medicine, Wonder, Wealth, Power, Vaishnyvaites -63

***In conclusio*n** here discussed about the ten impotant verses of vemana being in the meaning its expressed during those time as a indigenious thinker being in our place and literature which worth while to Telugu community

• • •

FREEDOM OF EXPRESSION
An Account of Ideology and Practice in Ancient and Medieval India

Rajendraprasad Sakharam Masurkar
Freelance Journalist and Visiting Lecturer of
Journalism & History (Gogate Jogalekar College, Ratnagiri)
Beside Phansop High School, Phansop, Ratnagiri.-415612.

1. In spite of the holy books, ancient Indian people produced treatises that stored varied knowledge Books and treatises produced in the ancient time are evidences of the ability of Indian thinkers. They theorized many such principles that are practiced today and they themselves even enjoyed them.

2. Before the rise of the Christian era, Indian people had achieved a certain stage of political thinking. Even before Asoka, the people had been enjoying their liberty to speak and to express their sentiments. In his famous book on polity- '*Arthas'âstra' Kautilya* had included '*Lokâyat'* as the third factor of *'nw î ks'iki'*, i.e. logic or metaphysics. The term '*Lokâyat'* may be defined as the public opinion. Considering this, there remains no room for the doubt whether the ancient thinkers had made assertion of the idea of 'Expression'. *Kºshna's* denial to the worship of Lord Indra and divulging of the succession of the mountain Govardhan is a significant fiction[9] that indicates the practice to question the established what Milton did far later in the 16th century.

3. Debates, discussions and symposia were regularly held in ancient universities[10] as they have been organized in the academies today to meet the goal of multifaced intellectual growth of the students. Etiquettes of debates and discussions had been composed in treatises about the 4th century. During fourth and fifth centuries, debates, crossing the limits of education, became a powerful tool for propagation of ideas, opinions and religious thoughts. Conference halls were constructed near big cities specifically for discussions. Symposia had their own place in ancient India. Known as *'Sambhâs'â'* the system is widely described in *Caraksamhitâ*. Existence of debates and discussions is itself a strong evidence of the existence of 'Freedom of Expression' in ancient and medieval India.

4. The 'freedom' enjoyed by the ancient and medieval Indians also seems to have been related with the religions movements. Emergence of new sects and assertion of new doctrines always received wide response. *S'ankarâcârya* stated his own theology to reform Hinduism in 9th century. Buddha must be taken in account

as a veteran religious reformer and revolutionist. Indian writers diligently applied their efforts through the Theatre to impose upon the public mind, their ideas and concepts. They seem to have been enjoyed full freedom to convey their thoughts on contemporary political and social situation.

5. The want of unawareness to maintenance of the treatises, destructive invasions and saturation of knowledge within a few communities rapidly dropped the intellectual advancement to darkness. However India possessed the knowledge long before the west. Excessive prevalence of traditions suppressed the growth of knowledge, especially during the Islamic an Maratha period. The responsibility goes to then thinkers and philosophers too.

6. The practice of enjoying the freedom seems to have been maintained during the medieval period too. Comparison of the work of John Milton to that of *Kavirâj Bhushan* would be interesting. Both belonged to seventeenth century. Milton stated the necessity of freedom of speech while *Bhûs'an*, through his poetry hauled over the coals of Aurangzeb, the Mugal Emperor, Milton stated the principle, *Bhûs'an* performed the exercise. Both ideology and practice of freedom of Expression were known to ancient and medieval India. However much stress was given on the practical performance than on the theory. Attempts of theorizing them were a few and whatever had been composed.

7. Yet, history has left room for a belief that there existed the idea of freedom of Expression in ancient and medieval India and the people in that prosperous past enjoyed it as a part of their life.

• • •

India's Contribution to World Civilization through formal education

S. C. Agarkar
Homi Bhabha Centre for Science Education
Tata Institute of Fundamental Research, Mumbai, India

India is the site of one of the most ancient civilizations in the world. It is one among those that started giving formal education to the young lads. There is a reference of gurukuls even in religious scriptures like Mahabharata and Ramayana. It had well defined stages of instruction from the ancient period. During the first period the child received instruction at home. The beginning of secondary education was marked by upnayana ritual that is thread ceremony. After this ceremony a child was expected to leave parent's house and live with a guru in an ashram. The period of studentship normally extended to 12 years. After finishing the education in ashram, the students would join a higher centre of learning or a university presided over by a kulpati (a founder of school of thought). There were opportunities for advanced studies through parishads or academy that encouraged philosophical discussions.

Formal education is a means of transferring the knowledge gained by the previous generation to the next generation. With its well defined formal education system (as described by the educational structures above) India had a significant contribution to world culture. Its influence on the cultures of central and Southeast Asia was profound. It was achieved both by trade relations and by political influence. Hindu rulers had established their territories extending upto Sumatra islands in Southeast Asia. One finds Sanskrit inscriptions at many places in this region. There are references to Indian philosophical ideas, legends/ myths and to Indian astronomical systems in the literature produced in Central and Southeast Asia.

The period of Guptas and Harshas was the golden age for Indian education. It was the age when Nalanda and Vallabhi were at their peaks. Their educational centres attracted students from various countries. Along with these places centres of higher education were established in Vikramasila, Odantpuri, Jagddala, etc. All these centres received a large number of students from different countries. These students then enabled the spread of formal education in their respective countries.

Science and mathematics saw their fast developments in the post Gupta period. These disciplines were formally taught at the centres of higher education within India. Many scholars learnt these disciplines in Indian universities and took them to their countries. The spread of science and technology had a profound effect on world culture. People now had an instrument of progress in their hands. This instrument changed the life style of people to a great extent and influenced their cultures.

• • •

ASSESSMENT SHEET

Sir / Madam,

In the modern times, Seminars and Workshops are playing a vital role in the dissemination of knowledge and are a source for acquiring further information, Co-operation and a better understanding between the organisers, participants and others attending the seminars is very important. A lot of money, time and energy is involved in organising such Seminars/ Workshops successfully. So it becomes essential that the Seminar/ Workshop should be truly assessed in the process of furthering knowledge.

We are giving you the questionnaire and we humbly request you to complete it with all seriousness and hand it over to us. If you are not attending the Seminar / Workshop, you can go through the abstracts and complete the form with your remarks and send the same to us by post. Such assessments will help us to realise our drawbacks and shortcomings, which will ultimately help us for better organising of such Seminars / Workshops in future.

While assessing the quality of the papers, the following points should be kept in view :

i. Overall presentation	ii. The language	iii. The arguments
iv. Relevance to the topic	v. Originality and	vi. Time.

The enclosed sheet should only be used for assessment. You have only to put a tick mark in the relevant square. No other remarks (except in the place provided for 'Remarks') are to be registered except the tick mark. Your remarks may be written in brief in the place provided for 'Remarks'.

Yours faithfully

V. V. Bedekar

(Dr. V.V. Bedekar)

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on

DAR¹ANA AND IT'S RELEVANCE TO INDIAN CULTURE

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