CALCULATION OF *AHARGAṆA* IN THE *VAṬEŚVARA SIDDHĀNTA*

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(*Received 10 February 1972*)

Ahargaṇa, i.e. the number of civil days from a certain epoch to another date, is an important quantity in Hindu astronomy because the knowledge of *ahargaṇa* on that date and the knowledge of the mean position of the planets at the time of the epoch, from which the *ahargaṇa* has been calculated, enable the astronomer to find the mean position of the planet on the later date. All astronomers have given various methods of calculating the *ahargaṇa*. Vaṭeśvara has devoted a whole chapter to this subject. The object of this paper is to review his methods and to bring out the meaning of certain stanzas which are in such a corrupt form in the printed book that it is difficult to understand their meaning clearly.

In order to calculate the *ahargaṇa* we need the number of sidereal days in a *yuga*, i.e. the number of revolutions of the asterisms, and the number of revolutions made by the sun and the moon in a *yuga*. The difference between the sidereal days and the number of revolutions made by the sun in a *yuga* gives the number of civil days in a *yuga*. The difference between the revolution numbers of the moon and those of the sun gives the lunar months, and thirty times the lunar months is the number of lunar *tithis* in a *yuga*. The difference between the lunar *tithis* and the civil days gives the number of *avama tithis*. The number of revolutions of the sun multiplied by twelve is the number of solar months and the difference between this and the number of lunar months gives the number of intercalary months or *adhimāsas*.

The number of sidereal days in a *yuga* according to Vaṭeśvara[1] is 1,582, 237,560, and the numbers of the revolutions of the sun and moon are respectively 4,320,000 and 57,753,336. From these we can derive the following:

Number of civil days in a *yuga* = 1,577,917,560.
Number of lunar months in a *yuga* = 53,433,336.
Number of solar months in a *yuga* = 51,840,000.
Number of intercalary months in a *yuga* = 1,593,336.
Number of lunar days in a *yuga* = 1,603,000,080.
Number of *avama tithis* in a *yuga* = 25,082,520.

The methods of calculating the *ahargaṇa* have been given by Vateśvara in the third chapter of *Madhyamādhikāra*. The first two stanzas have been devoted to the usual method given by the astronomers by which they calculate (i) the number of solar days; (ii) the number of intercalary months; (iii) the number of lunar and *avama tithis*; and (iv) the *ahargaṇa*. This method has been fully discussed by Bhattacharya and Sen.[2] Vaṭeśvara calculates the *ahargaṇa* from the birth of *Brahma* and not from the beginning of the *kalpa* as has been done by Brahmagupta and Śrīpati. The *ahargaṇa* has now to be divided by seven to get the lord of the day. According to the printed book we should count the remainder from Sunday. But according to Kuppanna Shastri[3] the day on which *Brahma* was born wàs Saturday. We will consider this point presently.

The Method of Brahmadeva Gaṇaka

Bhattacharya and Sen have also considered the simplified versions of this method given by Brahmagupta in *Khaṇḍakhādyaka* and by Brahmadeva Gaṇaka in *Karaṇaprakāśa*. The rationale of the methods adopted by Brahmagupta and Brahmadeva Gaṇaka was first explained by Schram in 1888.[4] Brahmadeva's method of calculating the *avama* days can also be derived by this method. If A is the number of *avama* days and L the number of lunar days

$$A=\frac{L\times 25{,}082{,}580}{1{,}603{,}000{,}080}=\frac{L\times 418{,}043}{26{,}716{,}668}$$

$$=\frac{L}{\dfrac{26{,}716{,}668}{418{,}043}}=\frac{L}{64-\dfrac{38{,}084}{418{,}043}}=\frac{L+D}{64}.$$

Then,

$$D=\frac{L\times 38{,}084}{26{,}716{,}668}=\frac{2L\times 19{,}042}{26{,}716{,}668}$$

$$=\frac{2L}{\dfrac{13{,}358{,}334}{9{,}521}}=\frac{2L}{1403\dfrac{371}{9{,}521}}$$

$$=\frac{2L}{1403}.$$

It can be easily seen that the method adopted by Brahmadeva Gaṇaka is less accurate than that of Brahmagupta though the former is a little easier in calculation. Bhattacharya and Sen have given the method explained by S. Dvivedi in his commentary on *Karaṇaprakāśa*.[5]

Puliśa Siddhānta's Method

Some other Indian astronomers have included a similar method in their *siddhāntas*.[6] Vaṭeśvara has also given a similar method in stanzas 22 and

23 of chapter III of *Madhyamādhikāra*. However, these two stanzas have been printed in a very corrupt form and the meaning given by the commentators is as follows:

'Write the number of the elapsed solar days in two places; in one place multiply it by the number of lunar signs and divide the product by 4,050,000. From the quotient subtract 302,976 and add the remainder to the solar days in the other place and divide by the above divisor. Put the quotient in two places. In one place add 1,651,030 and divide by 703. The quotient of this division should be subtracted from the number in the other place to obtain the number of civil days.'

The commentators later state that *candrabha* represents 271 and multiplying the elapsed solar days by this number and dividing by 4,050,000, we obtain the *adhimāsa* days which added to the solar days gives the lunar days. Then they make an attempt to calculate the *avama* days but finally give up the attempt indicating that the stanzas are defective.

Actually in these two stanzas Vaṭeśvara first calculates the number of *adhimāsa* months by the method of the *Puliśa Siddhānta* which has been given by al-Bīrūnī.[7] However, al-Bīrūnī was unable to appreciate this method and says: 'Here, however, I suspect either the copyist or the translator for Puliśa was too good a scholar to commit similar blunders.' But as has been shown by Schram the method is all right.[8] According to al-Bīrūnī the method of Puliśa is the following:

'You write this number of days in two different places. In the one place you multiply it by 271 and divide the product by 4,050,000. The quotient you subtract from the number in the other place and divide the remainder by 976. The quotient is the number of *adhimāsa* months, days and day fractions.'

The number of *adhimāsa* months in a *yuga*, according to the school of Āryabhaṭa is, as stated above, 1,593,336. Hence the average number of solar days after which an *adhimāsa* will occur is $\frac{51,840,000\times 30}{1,593,336}$. If S is the number of elapsed solar days, the number of *adhimāsa* months, A, is given by

$$A = \frac{S}{\frac{1,555,200,000}{1,593,336}} = \frac{S}{976\frac{104,064}{1,593,336}}$$

$$= \frac{S-X}{976}$$

where

$$X = S\frac{104,064}{1,555,200,000}$$

$$= S\frac{271}{4,050,000}.$$

If we multiply A by 30 and add the product to the number of solar days, we get the number of lunar days. Let this number be L. The number of *avama* days in a *yuga* according to Vaṭeśvara is different from the number according to Āryabhaṭa and Bhāskara I. If D is the desired number of *avama* days, we have

$$D = \frac{L \times 25{,}082{,}520}{1{,}603{,}000{,}080} = \frac{11L}{\dfrac{11 \times 1{,}603{,}000{,}080}{25{,}082{,}520}}$$

$$= \frac{11L}{703 - \dfrac{1{,}068}{2{,}508{,}252}} = \frac{11L + Y}{703}$$

where

$$Y = \frac{11L \times 1{,}068}{1{,}763{,}300{,}088} = \frac{11L}{\dfrac{1{,}763{,}300{,}080}{1{,}068}}$$

$$= \frac{11L}{1{,}651{,}030\dfrac{12}{267}}$$

$$= \frac{11L}{1{,}651{,}030}.$$

The above stanzas after calculating the *adhimāsa* months direct that the *adhimāsa* days should be added to solar days to get the number of lunar days. The number of lunar days should be multiplied by 11 and the product written in two places. In one place it should be divided by 1,651,030 and the quotient added to the product placed in the second place. The sum divided by 703 gives the *avama* days which subtracted from the number of lunar days gives the number of civil days. The two stanzas therefore should read as:

pṛthaginadinarāśi ścandra bhaghno vibhaktaḥ
śataguṇita khakeṣuvyomavedairvihīnaḥ |
rasanaganava labdhirvyomarāmaiśca yuktaḥ
pṛthagina hata rāśirdviṣṭhaīśairvibhaktaḥ ||
khāgnikhaika śaraṣaṇmukhairyuto rāmakhāgabhajitāpta varjitaḥ |
syad dyurāśi ravi sāvano'thavā sūryamā sanikaro dvidhā sthitaḥ ||

The last quarter of the second stanza is connected with the next two stanzas.

This method of calculating the *avama* is the same as the one given by Brahmagupta in his *Khaṇḍakhādyaka* and by Āryabhaṭa II in his *Mahāsiddhānta* though the additive fractions are different from each other because the astronomical constants are different. Actually in the calculations of Āryabhaṭa II a certain fraction has to be subtracted before dividing by 703.

Other Methods of Vaṭeśvara

In the next two stanzas Vaṭeśvara gives another method of calculating the *ahargaṇa*. For this method he recommends as follows:

Write the number of solar months in two places. In one place multiply it by 66,389 and divide by 2,160,000. Add the number of the months to the number in the other place and multiply the sum by 30. To this number add the number of *tithis* of the present month. Write this sum in two places. In one place multiply it by 209,021 and divide the product by the 120th part of lunar days in a *yuga*. Subtract the quotient from the number in the second place to get the number of civil days.

The translation of the first part has been correctly given by the commentators. However, in the second part they say that the product of the lunar days and 209,021 should be divided by 12th part of lunar days in a *yuga*. They did not realise that this would reduce the number of *avama* days by a factor 10.

The rationale of the method is as follows:

The numbers of intercalary months and solar months in a *yuga* is respectively, 1,593,336 and 51,840,000. Hence the number of intercalary months A in S solar months will be given by

$$A = \frac{S \times 1{,}593{,}336}{51{,}840{,}000} = \frac{S \times 66{,}389}{2{,}160{,}000}.$$

This added to S and the sum multiplied by 30 and added to *tithis* of current month gives the number of lunar days. Now the number of *avama* days D will be given by

$$D = \frac{L \times 25{,}082{,}520}{1{,}603{,}000{,}080} = \frac{L \times 209{,}021}{\frac{1{,}603{,}000{,}080}{120}}$$

$$= \frac{L \times 209{,}021}{13{,}358{,}334}.$$

This method is the same as that given by Srīpati[9] and similar to the one given by Lalla[10] and Bhāskara I.[11]

We will now consider stanzas 16–18 in which Vaṭeśvara has given the calculation of *ahargaṇa* from the birth of *Brahma* to the beginning of *Kaliyuga*. The commentators translate them as follows:

'In the beginning of the day of *Brahma* 16,199,200 civil days had elapsed. In the beginning of *Kṛtayuga* the past *yuga* years equal to three-fourths of a *Mahāyuga* had elapsed. The sum of the above values is the *ahargaṇa* in the beginning of *Kaliyuga* or one-fourth of the number of civil days in a *kalpa* multiplied by 24,798,639 gives 97,825,519,855,210 which is the *ahargaṇa* in the beginning of *Kaliyuga*. On adding to this the *ahargaṇa* of elapsed *Kaliyuga* one gets the desired *ahargaṇa* from the beginning of the *kalpa*.

The self-contradiction in the above explanation is obvious. How can one-fourth of the civil days in a *kalpa* multiplied by a large number give the *ahargaṇa* from the beginning of the *kalpa*? The commentators have entirely missed the meaning of Vaṭeśvara. As has been pointed out by Kuppanna Shastri, according to Vaṭeśvara, the age of *Brahma* up to the beginning of the present day of *Brahma* is 8 years, 6 months and 15 days. This converted in *yugas* is 6,199,200 and the three stanzas should be translated as follows:

'The number obtained by multiplying 6,199,200 by the number of civil days (in a *yuga*) is the *ahargaṇa* at the beginning of the (present) day of *Brahma* (to get the *ahargaṇa*) at the beginning of the present *Kṛtayuga*, the number of elapsed *yugas*, i.e. 459 (should be multiplied by the number of civil days in a *yuga*). Again (this number) multiplied by 3 and divided by 4 (gives the *ahargaṇa*) up to the beginning of *Kaliyuga*. The sum of all the three numbers gives the *ahargaṇa* from the birth of *Brahma* to the beginning of *Kaliyuga*. Or one-fourth of the number of civil days (in a *yuga*) multiplied by 24,798,639, i.e. the number 9,782,551,985,550,210, is the *ahargaṇa* up to the beginning of *Kaliyuga*. To get the desired *ahargaṇa*, the *ahargaṇa* from the beginning of *Kaliyuga* should be added to it.'

The whole confusion has arisen on account of the corrupt text of stanza 16. The correct reading is *Śūnyanakhāṅkanavaikarasaghnā bhūdivasā dyugaṇaḥ kadinādau | Yāta yugādigaṇaśca kṛtādau tiṣyamukhastriguṇaḥ kṛtabhaktaḥ*.

But in the printed text *rasaghnā* is printed as *raselā* so that the number 6,199,200 and the idea of multiplication was suppressed. Also *yugādi* has been printed as *yugābda* and *tiṣyamukhas* as *tibyamukhas*.

The above number of civil days up to the beginning of *Kaliyuga* leaves a remainder 6 when divided by 7. Therefore the life of *Brahma* began on a Saturday in order that *Kaliyuga* may begin on Friday. It is on this basis that Kuppanna Shastri has suggested that the stanza 11.9 of *Madhyamādhikāra* should be modified to read *śanerdine* instead of *raverdine*. Since the number of days in a *kalpa* is, according to Āryabhaṭa's school, divisible by 7, every *kalpa* will begin on a Saturday and end on a Friday.

However, this raises a difficulty. In stanza 19, Vaṭeśvara says that in order to get the lord of the day the *ahargaṇa* must be subtracted from seven times the number of civil days in a *kalpa*, the number obtained divided by 7 and the remainder counted backwards beginning from Saturday, Friday, etc. If the value of the *ahargaṇa* is such that on dividing it by 7 the remainder is 1, the remainder, after dividing by 7, the difference between it and seven times the number of civil days in a *kalpa* will be 6. To get Saturday the counting must be begun from Thursday.

Stanzas 10–15 and the last stanza 26 are devoted to the calculation of the lunar days, *śuddhi* and civil days by multiplying the number of elpased years by certain numbers and dividing by certain other numbers. These multiplying and dividing numbers depend upon the fact that the number of lunar days, according to Vaṭeśvara, is 371/3/53/24 in a year and the number of civil days is 365/15/31/18. But the commentators have adopted Brahmagupta's value for the number of lunar days and Āryabhaṭa's value for the number of civil days. They get the fractions given by Vaṭeśvara because they do not actually perform the calculations. These methods are different variations of the method given by Śrīpati.[12]

Stanza 3 gives the following rule for calculating the *ahargaṇa*:

$$Ahargaṇa = \left[\frac{\text{elapsed solar months} \times \text{lunar days in a } yuga}{\text{solar days in a } yuga} \times 30 + X\right] \frac{T}{Z}.$$

Where X = elapsed *tithis* since the last new moon,

T = number of civil days in a *yuga*,

Z = number of lunar days in a *yuga*.

It is evident that in this calculation only the integral number of lunar months will be taken. This is similar to the method given by Śrīpati.[13]

In the next stanza, the *ahargaṇa* is to be obtained by multiplying the elapsed solar days by civil days in a *yuga* and dividing by the solar days in a *yuga*. This method has also been given by Śrīpati.[14]

The method given in stanza 5 depends upon the fact that the difference between the *adhimāsa* days and *avama* days in a *yuga* is equal to the difference between the civil days and solar days in a *yuga*. Therefore

$$\frac{(adhimāsa \text{ days in a } yuga - avama \text{ days in a } yuga) \text{ elapsed solar days}}{\text{solar days in a } yuga}$$

$$= \frac{(\text{civil days in a } yuga - \text{solar days in a } yuga) \text{ elapsed solar days}}{\text{solar days in a } yuga}$$

$$= ahargaṇa - \text{elapsed solar days.}$$

Before proceeding to consider the next two stanzas we have to understand two technical terms. In calculating the *ahargaṇa*, we first calculate the elapsed intercalary months. For this purpose we multiply the elapsed solar days by the number of intercalary months in a *yuga* and divide the product by the number of solar days in a *yuga*. The quotient is the elaspsed intercalary months. The remainder is known as *adhimāsaśeṣa*.

Let

X = number of solar days in a *yuga*,

Y = intercalary months in a *yuga*,

a = number of elapsed solar days,

b = integral number of elapsed intercalary months.

Then $a \cdot Y = b \cdot X + adhimāsaśeṣa$. .. .. (1)

Also let

Z = lunar days in a *yuga*,
T = civil days in a *yuga*,
U = *avama* days in a *yuga*,
c = integral number of elapsed lunar days,
d = *ahargaṇa*,
e = integral number of past *avama* days.

Then a quantity *avamaśeṣa* is defined by the relation

$$c \,.\, U = e \,.\, Z + avamaśeṣa. \qquad \ldots \quad (2)$$

We also have the relations

$$Z = X + 30Y = T + U \qquad \ldots \quad (3)$$

and

$$c = a + 30b = d + e. \qquad \ldots \quad (4)$$

Subtracting the product $e \,.\, U$ from both sides of (2) and using (3) and (4), we have

$$d \,.\, U = e \,.\, T + avamaśeṣa, \qquad \ldots \quad (5)$$

or

$$d = \frac{1}{U}\,(e \,.\, T + avamaśeṣa). \qquad \ldots \quad (6)$$

Also from (5) we can deduce that

$$e = \frac{1}{T}\,(d \,.\, U - avamaśeṣa).$$

Adding d to both sides and using (1), we have

$$c = \frac{1}{T}\,(d \,.\, U - avamaśeṣa) + d$$

$$= \frac{1}{T}\,(d \,.\, Z - avamaśeṣa). \qquad \ldots \quad (7)$$

Again adding $30b \,.\, Y$ to both sides of (1), we have

$$c \,.\, Y = b \,.\, Z + adhimāśeṣa \qquad \ldots \quad (8)$$

or

$$b + \frac{1}{Z}\,adhimāsaśeṣa = \frac{Y}{Z} \times c$$

$$= \frac{Y}{ZT}\,(d \,.\, Z - avamaśeṣa)$$

or

$$d \,.\, Y = bT + \frac{1}{Z}\,(Y \,.\, avamaśeṣa + T \,.\, adhimāsaśeṣa)$$

$$= bT + sphuṭādhimāsaśeṣa$$

or

$$d = \frac{1}{Y}\ (bT + sphuṭādhimāsaśeṣa) \qquad \ldots \qquad \ldots \qquad \ldots \qquad (9)$$

where $sphuṭādhimāsaśeṣa = \frac{1}{Z}\,(Y\,.\,avamaśeṣa + T\,.\,adhimāsaśeṣa)$ .. (10)

Vaṭeśvara, in stanza 6, first defines *sphuṭādhimāsaśeṣa* as given in equation (10) and then in the first line of stanza 7 directs the calculation of *ahargaṇa* according to equation (9) and in the second line according to equation (6). These methods have been given by Brahmagupta also.[15]

Calculation of Solar Days from Civil Days

In stanza 20, Vaṭeśvara directs us how to find the elapsed solar days from the *ahargaṇa*. He first calculates e using (5) by the relation

$$e = \frac{d\,.\,U}{T} - \frac{1}{T}\ avamaśeṣa.$$

Adding this to d we get c and then using (8),

$$b = \frac{cY}{Z} - \frac{1}{Z}\ adhimāsaśeṣa.$$

Finally from equation (4),

$$a = c - 30b.$$

A similar method has been given by Brahmagupta.[16] The only difference is that Brahmagupta directly calculates c using equation (7).

The meaning of stanza 22 is not very clear. Perhaps it gives the method of calculating the solar days starting with the past *avama* days as has been done by Brahmagupta.[17] Or it may mean the mutual dependence of the different quantities.

Finally, we come to stanzas 8 and 9 which are again not very clear. The commentators have translated stanza 8 as follows:

'Multiply the elapsed solar days by the revolutions of the moon. Subtract thirteen times the solar days and change the remainder into degrees. On adding five times the number of years, we obtain *śuddhi* days.'

But this is not the definition of *śuddhi* days.

śaśadhara bhagaṇaghne yātasūryadyurāśau
yugaravidinabhakte maṇḍalādiḥ śaśāṅkaḥ.
Trikahatadinahīno'sau ca bhāgādiko'
ksairapihatagatavarṣairanvitaḥ śuddhyahāni.

Its meaning probably is this:

'Multiplying the number of revolutions of the moon in a *yuga* by the elapsed solar days and dividing by the number of solar days in a *yuga*, we obtain the revolutions, etc., of the moon. Convert it into degrees and subtract from the result thirteen times the number of solar days. Convert the remainder into *tithis* and subtract from the result five times the elapsed years and we get the *śuddhi* days.'

But this will also not give the *śuddhi* days.

The next stanza is:

bhodayairgatakharāṃśuvāsarāḥ sanguṇā yugadineśavāsarāiḥ |
bhājitāḥ kathitaśuddhivarjitāḥ syāddyuraśirathavaiksaṃyutaḥ ||

The meaning is: Multiply the number of the risings of the asterisms by the elapsed solar days and divide by the number of solar days in a *yuga*. Subtract from the quotient the aforesaid *śuddhi* and the remainder is the number of civil days. Or one has to be added.

Now we know that

$$\text{number of risings of the asterisms in a } yuga$$
$$= \text{number of civil days in a } yuga + \text{number of solar revolutions in a } yuga$$
$$\therefore \frac{\text{number of risings of the asterisms in a } yuga \times \text{elapsed solar days}}{\text{solar days in a } yuga}$$
$$= \frac{(\text{civil days in a } yuga + \text{solar revolutions in a } yuga)\text{ elapsed solar days}}{\text{solar days in a } yuga}$$
$$= ahargaṇa + \text{number of elapsed years.}$$

Therefore the subtractive quantity is not the above *śuddhi* but the number of elapsed solar years.

It seems the text is very defective and lines from different stanzas have got mixed up.

While discussing the number of *avama* days according to *Karaṇasāra* of Vaṭeśvara, al-Bīrūnī says:[18]

'However, as I have not been able to find the proper explanation for this method, I simply give it as I find it, but I must remark that the amount of *ūnarātra* days which corresponds to a single *adhimāsa* month is $15\frac{7,887}{10,622}$.'

From the context in which it has been stated, it is likely to give the impression that the above number of *ūnarātra* days is according to *Karaṇasāra*. Actually the above value pertains to the constants given by Brahmagupta in *Brāhmasphuṭasiddhānta*. The number of *ūnarātra* days which corresponds to one *adhimāsa* month according to Vaṭeśvara is $15\frac{49,270}{66,389}$.

References

[1] *Vaṭeśvara Siddhānta*, ed. R. S. Sharma and M. Misra. Institute of Astronomical and Sanskrit Research, New Delhi, 1962. Chapter III. *Madhyamādhikāra*

[2] S. P. Bhattacharya and S. N. Sen, *Ahargaṇa* in Hindu Astronomy, *Indian Journal of History of Science*, Vol. IV (1969), p. 144.

[3] T. S. Kuppana Shastri, The system of *Vaṭeśvarasiddhānta*, *Indian Journal of History of Science*, Vol. IV (1969), p. 135.

[4] *Al-Bīrūnī's India*, Vol. II, p. 372.

[5] *Karaṇaprakāśa* by Brahmadeva Gaṇaka, edited by S. Dvivedi. Chowkhamba Sanskrit Series, Benares (1899), pp. 2–3.

[6] *Mahāsiddhānta* by Āryabhaṭa II, edited by S. Dvivedi and published by Braj Bhusan Das & Co., Benares, 1910, I, 23–24; Lalla, *Sisyadhīvṛdhida*, I, 20, a method for calculating *adhimāsa* months similar to that of Lalla and of Brahmadeva Gaṇaka and a method of calculating the *avama* days similar to that of Brahmagupta in *Khaṇḍakhādyaka* and others but both methods depending upon the constants of *Brāhmasphuṭasiddhānta* have been described by al-Bīrūnī (see *India*, Vol. II, pp. 35–36). But al-Bīrūnī does not state from which book he has taken this method.

[7] *Al-Bīrūnī's India*, Vol. II, pp. 41–42.

[8] *Ibid.*, p. 371.

[9] Śrīpati, Siddhānta-Śekhara, ed. by Babuaji Misra, Calcutta University, Part I, p. 45.

[10] Lalla, *Sisyadhivṛdhida*, I, 18.

[11] Bhāskara I, *Mahābhāskarīya*, I, 7.

[12] Śrīpati, Siddhānta-Śekhara, Part I, p. 40.

[13] *Ibid.*, p. 39.

[14] *Ibid.*, p. 38.

[15] Brahmagupta, *Brāhmasphuṭasiddhānta*, XIII, 15–17.

[16] *Ibid.*, XIII, 14.

[17] *Ibid.*, XIII, 12–13.

[18] *Al-Bīrūnī's India*, Vol. II, p. 56.

The present article is a humble attempt to hint at certain salient features of Vedic literature and to correlate that knowledge with later findings. In the Vedas there has been the reference to nearly 150 plants including *aśvattha, khadira, kuṣṭha, soma, palāśa, nyāgrodha, pippalī, bilva, udumbar, apāmārga,* etc., along with their properties and uses. If the whole list be submitted it will be too lengthy, hence in this paper we will restrict ourselves to the description of a few of the main plants and the comparison of their properties as has been revealed due to recent findings, with those on record in Vedic literature.

Aśvattha is regarded as one of the most holy and important trees in the Indian culture. It has been referred to as a male tree as—

पुमान् पुंसः परिजातोश्वत्थो खादिरादधि
स हन्तु शत्रून् मामकान् यानहं द्वेष्मि ये च माम् ।।[1]

In the above *sūkta* it is desired to kill the enemies by '*maṇi*' prepared from *aśvattha* (*Ficus religiosa*) and *khadira* (*Acacia catechu*). Here it is worth mentioning that in each *ṛcas* or *sūkta* of Vedas, one or the other God is prayed to achieve one or the other end such as to gain prosperity or to kill enemies, etc. In the above *sūkta* the word '*dveṣmi*' is derived from *dveṣa*; the meaning of *dveṣa* (jealousy) according to Yoga philosophy is producer of pain, as—

दुःखानुशयी द्वेषः[2]

As diseases render pain, hence from the human point of view they can be referred to as '*dveṣī*'. And the eradication of these jealous diseases is one of the properties of *aśvattha* which has been hinted at in the above *sūkta*. Regarding the curative properties of *aśvattha* the following has been the mention in recent literature—

अश्वत्थ के गुणधर्म—श्वयथु विलायक, रूक्षक, छर्दिघ्न और उबकाई दूर करनेवाला; विशेषतः, फोड़े बैठानेवाला है। छाल में कषायसत्व (Tannin), रबड़ (काउचूक) और मोम होता है, छाल को उबाल कर उसे काढ़े से दंतवेष्टशोथ और मुखपाक में कवलग्रह कराते हैं।[3]

The bark is astringent and is used in gonorrhoea. . . . Fruits are laxative and seeds are cooling. The leaves and young shoots are used as purgative; . . . infusion of bark is given internally in scabies . . . the bark contains some tannin and is used for preparing leather and for dyeing.[4]

In the above *sūkta*[5] there has been the mention of *khadira* (*Acacia catechu*) along with *aśvattha*. There are other references to *khadira* also as—

अभि व्ययस्व खदिरस्य सारम्[6]

for which recent literatures reveal—

यह शीत संग्राही, रक्त प्रसादक, व्रणलेखक और उदरकृमिनाशक है। दांतों से खून आने और गलशुण्डिका में यह विशेष लाभकारी है। इसका अतिसार में उपयोग होता है। व्रणों में मलहम बनाकर इसका उपयोग किया जाता है।[7]

The bark contains tannin, which is used for tanning and dyeing.[8]

There are references to ecology of plants in Vedas. To quote one—

असित ते प्रलयनमास्थानमसितं तव।
असिकन्यस्योषधी निरसो नाशया पृषन्॥[9]

"O! Black or blue medicine, your place of growth is black and you turn those substances black, with which you are associated. As is your colour so is your property. Hence your application may cure such diseases which produce spots, e.g. leprosy".

In modern literature it is said—

The plant of *Indigofera tinctoria* is a small herb to shrub. It yields a dye—indigo, which is used in dyeing. Indican is the principal glucoside.[10]

Palāśa (*Butea monosperma*) has been mentioned often in Vedic literature as—

सोमो वै पलाशम्[11]

It has also been referred to as '*parṇa*'—as—

विसोमेन वा एके पशुबंधने यजन्ते।
ससो मेनैके दिवि वै सोम आसीत गायत्री क्योभूत्वा।
हरत्तस्य यत्पर्णं मिच्छिद्यत तत्पर्णस्य पर्णत्वम्॥[12]

As in the above it is supposed to take its origin from the fallen feathers of *Gāyatrī* or fallen leaves of '*Soma*'.

In one reference it has been mentioned as Brahma.[13]

If we compare it with modern literature—

गुणधर्म—छाल और पत्र संग्राही, वीर्यपुष्टिकर, उदरकृमिनाशक, वाजीकर और मूत्रार्तवजनक है—बीज-वातानुलोमक, उदरकृमिनाशक, चतुर्थकज्वरनाशक, लेखन, व्रणकारक, सर्प-वृश्चिक विषघ्न है। गोंद शुक्रस्तम्भन, वीर्यपुष्टिकर, उपशोषक और आमाशय संग्राहक है।[14]

Butea monosperma has ornamental flowers, it yields dyes. The bark and gum contain tannic and gallic acid. Seeds contain Moodooga oil or a kind of tree oil . . . seeds are anthelmintic and antidote for snake-bite . . . gum is given in diarrhoea and dysentery.[15]

17, 18 and 19 *sūktas* of IV *kāṇḍa* of the *Atharvaveda* contain references to *apāmārga* (*Achyranthus aspera*); as—

अपामार्ग त्वया वयं सर्वं तदप मृज्महे[16]

In the above *sūkta* there is detailed description of physiology, ecology, etc., of *Achyranthus*. Similarly, *audumber* finds reference at many places. The botanical name of which is *Ficus glomerata*, as—

औदुम्बरेण मणिना पुष्टिकामाय वेधसा[17]

In fact 31st *sūkta* pertains to *audumber maṇi*. This plant is very important from medicinal point of view. In this respect, its bark, latex and fruits are useful.

Related to it is another important plant *Ficus bengalensis* which finds its mention in the name of *nyāgrodha* in ancient literatures, as—

यत्राश्वत्था न्यग्रोधा महावृक्षाः शिखण्डिनः ।
तत् परेताप्सरसः प्रतिबुद्धाः अभूतन् ।।[18]

It contains latex—a milky juice. It starts its life as epiphyte. Latex is used in rheumatism and lumbago. Infusion of bark is used in dysentery, diarrhoea and diabetes. The leaves are applied as poultice to abscess.[19]

In the Vedas references to plants were also made for showing simile, e.g.

उर्वारुकमिव बन्धनात्[20]

In the above *sūkta* the bondage of cord is compared with the twining habit of cucumber. The tendril of cucumber helps to climb it over the support.

The reference to *pippalī* (*Piper longum*) is as follows—

पिप्पली क्षिप्तभेषज्यूतानि विद्धभेषजी[21]

It shows the curative value of piper. In *Āyurveda*, piper has hot and dry properties. It is stimulant, heat-producing and digestive.

Similarly *Piper longum* is a twiner, it contains an alkaloid known as piperine, which has got medicinal value.[22]

In the *Atharvaveda*, *bilva* (*Aegle marmelos*) is referred to as follows—

महान वै भद्रो बिल्वो महान भद्र उदुम्बर[23]

It has also been referred to along with *Khadira* in *Śatapatha Brāhmaṇa*.[24]

In *Āyurveda*, its fruit is considered to be cool and dry. It is mentioned as blood purifier. The bark of the tree cures fever.

According to recent findings the principal constituent of the pulp is marmelosin. It also contains sugar, pectin, tannin, essential oils, etc. The boiled or roasted unripe fruit is used in diarrhoea and dysentery. The seeds and fruits yield a dye.[25]

In the last, the mention of a plant is absolutely essential without which this paper will be incomplete. This plant has been much discussed and its identity is widely disputed; that plant is '*Soma*'. *Soma* has been considered as the best amongst medicines, e.g.

यथा सोम ओषधीनामुत्तमो हविषां कृतः ।
तलाशा वृक्षाणाभिवाहं भूयसमुत्तमः ॥[26]

There is detailed account of *Soma* in IX *maṇḍala* of the *Ṛgveda* and in *Caraka Soma valka* 4·15 and hence it cannot be considered as imaginary. According to Dr. Atkinson this plant is *Ephedra pachyclada* and whose name in Harirud valley is *Hum* or *Yahma*. Dr. Bornmuller considers *Soma* to be *E. distachya* while Lawson, Muller, etc., consider it to be *Sarcostemma brevistigma* and both believe it to be *S. acidum*. Rice is of the view that it is nothing else than sugarcane (*Saccharum officinarum*), whose juice can be easily extracted and widely relished. While there are others who hold that it is *Humulus lupulus*.

From the above account, it is evident that its identity is much disputed and to come to any definite conclusion is quite difficult. We shall discuss at length about the identity, properties, uses and origin of *Soma* in another article fully devoted for this purpose, but here it can be said that our sages and *ṛṣis* in those days were used to take *Soma* for drinking regularly, so that they could lead healthy, cheerful and longer life.

In addition to these, numerous examples can be cited which prove that the Science of Botany in those days was highly developed as compared to that in other countries of the world and from here had dissipated this knowledge to various parts of the world.

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