Botanical Facets of *Bṛhat Saṃhita* - Varāhamihira's *Magnum Opus*

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Abstract

Varāhamihira's most famous work was *Bṛhat Saṃhita*. It is an encyclopedic work on architecture, temples, planetary motions and many other topics. The *Bṛhat Saṃhita* described various morphologic and physiologic features of vegetation as hydrologic indicators to locate sources of ground water at different depths. Hence, the *Bṛhat Saṃhita* establishes Varāhamihira as the first hydrologist who codified all the then existing knowledge on the subject in his magnum opus. Altogether, there are more than 545 herbs, shrubs, trees and crops that were mentioned in the two parts of *Bṛhat Saṃhita*. The *vṛkṣāyurveda* chapter deals with treatment of plant diseases and prescriptions of remedies, nutritional and other aspects of plant life. The plants that are revealed in the *Bṛhat Saṃhita* can be classified into huge trees, edible fruit trees, shrubs, herbs, creepers, water plants, grasses, pulses, cereals, wild cereals and others, as per the Bentham and Hooker taxonomic system of plant classification. Till date, there is no systematic study on the flora or botany of this historical work on *Bṛhat Saṃhita*. Therefore, a systematic floristic study and the uses of these plants/trees are comprehensively discussed in this review article.

Key words: *Varāhamihira, Bṛhat Saṃhita, plants, flora, plant indicators, floristic analysis*

Introduction

Trees and forests augment manifold the beauty of the earth. They are the very basis of human life and the biosphere. Plants are one of Earth's greatest resources. They are sources of food, medicines and materials with vast economic and cultural importance. In the four Vedas, there are many herbs, vines, shrubs and tree species are described [4]. Following the Vedic texts and tradition, several ancient epics to till recent Sanskrit texts described various plants and trees that are useful for humanity.

One such Sanskrit text that was the most valuable contribution to the scientific world is the *Bṛhat Saṃhita* by Varāhamihira.

The *Bṛhat Saṃhita* deals with a wide range of subjects of human interest, such as astrology, planetary movements, eclipses, rainfall, clouds, architecture, growth of crops, manufacture of perfume, matrimony, domestic relations, gems, pearls, and rituals [3, 5, 7]. Each of these subjects has been treated, keeping in view its significance as an augury or its astrological effects [15].

Varāhamihira and his Monumental Works

Acharya Varāhamihira, son of Ādityadāsa, also called Varāha or Mihira, born in the year 505 in Avanti, Ujjain, Madhya Pradesh, India and died in 587. According to one of his own works, he was educated at Kapitthaka [17, 18, 12]. He was an Indian

philosopher, astronomer, mathematician and editor of the *Pancha-siddhantika* (Five Treatises, as we know it), a compendium of Greek, Egyptian, Roman, and Indian astronomy [3, 7].

Varāhamihira studied *Jyotiṣa* (astrology) from his father, Ādityadāsa. Both father and son were worshippers of Sun God. Āryabhata, the celebrated astronomer was older than Varāhamihira but the two met frequently at Kusumapura in Magadhadesa. Varahamihira's knowledge of Western astronomy was thorough. An intellectual with a broad outlook, Varāhamihira who respected learning wherever it was found, was intimately acquainted with the astrological literature of the Greeks to which he makes a reference in his works, but he was not a blind follower of old ideas. The outstanding works of Varāhamihira are - (1) *Panchasiddhantika*, (2) *Vivahapatala*, (3) *Bṛhajjātaka*, (4) *Laghujātaka*, (5) *Yātra* and (6) *Bṛhat Saṃhita* possibly written in that order. The *Panchasiddhantika* is a summarization of five *siddhāntic* texts that were known to Varāhamihira. These are, (1) *Saura Siddhāntika*, (2) *Pauliśa Siddhāntika*, (3) *Romaka Siddhāntika*, (4) Vaśiṣṭha *Siddhāntika* and (5) *Paitāmaha Siddhāntika* [3, 5].

Varāhamihira belongs to the galaxy of Indian scientists that include Dhanvantari, Caraka, Śuśruta, Āryabhata and Bhāskarācharya whose fields of specialization ranged from medicine and surgery to mathematics. In the long history of *Bharatiya Jyotiṣa* (Indian Astrology), Varāhamihira stands supreme as a versatile personality. His greatest work, *Bṛhat Saṃhita,* deals with an astonishing variety of subjects of exceptional interest and value. Al Biruni, the Arabian
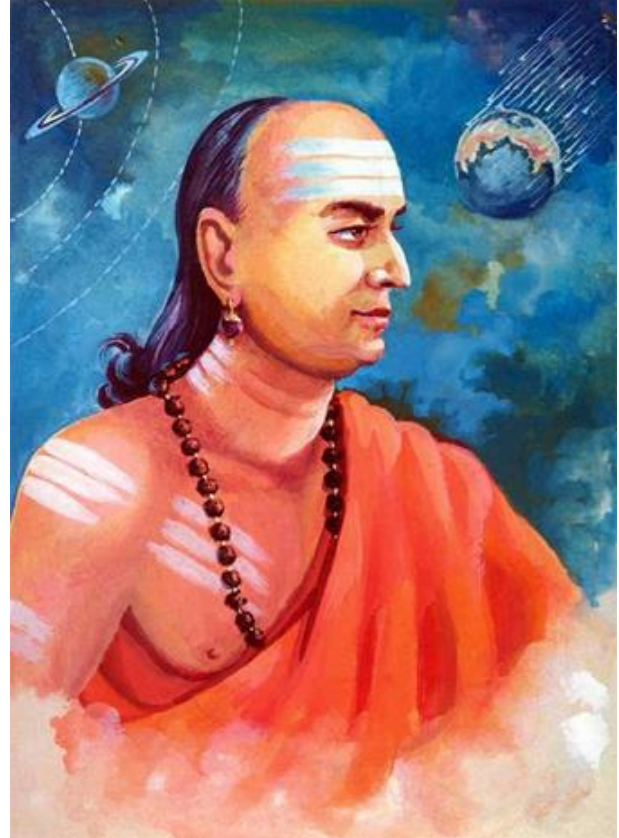
astronomer who translated the *Laghujātaka* of Varāhamihira into Arabic, eulogizes the *Bṛhat Saṃhita* for its richness in details [2]. Astronomy, architecture, sculpture, medicine, psychology, physiology, botany, zoology, groundwater and other subjects are treated in a masterly fashion and the language and style used prove Varāhamihira to be a poet of high order in Sanskrit. He had a great admiration for Kāḻidāsa. A later tradition includes them among the nine jewels of Vikramāditya's court, but their contemporaneity has been disproved [14].

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Previous works on Bṛhat Saṃhita

A perusal of literature survey indicates that majority of published information of *Bṛhat Saṃhitā* is on the *Jyotiṣa* and astronomy. Iyer (1984) published the *Bṛhat Saṃhita* in two volumes with English translation. Bhaṭṭotpala [3] made a commentary for all ślokas of *Bṛhat Saṃhita* in Sanskrit language. Seal [16] published information on chapter 54 of *Bṛhat Saṃhita* with English translation of the Sanskrit ślokas of Varāhamihira. Majumdar [10] published a book on *Vanaspati* wherein he brought out some rudimentary information on the chapter 54 of *Bṛhat Saṃhita*. Sastri and Bhat [15] brought a book on *Bṛhat Saṃhita* with English translation and notes. Shastri [17] published a book on *Bṛhat Saṃhita*. Prasad [13] published a research article on plant indicators of *Bṛhat Saṃhita* of chapter 54. Sarma [14] published a book on Varāhamihira. Murthy [11] published an article on Varāhamihira, the earliest hydrologist with information on plants of chapter 54. Bhat [2] brought a two voluminous book on English translated *Bṛhat Saṃhita*. Vanadeep *et al*., [20] studied 27 meteorological predictions and were compared with the on-site real-time recorded values of meteorological parameters like rainfall, wind velocity, wind direction, cloud direction, etc. over four Indian regions. Joshi *et al*., [8]

published an ancient water exploration technique based on Varāhamihira's *Bṛhat Saṃhita*. Majority of the publications provided information on the plants of chapter 54 of *Bṛhat Saṃhita*. Goyal [6] brought out a report on the ancient water exploration practices based on Varāhamihira's *Bṛhat Saṃhita* and the results have been discussed considering conditions prevailing in forests and deserts separately. It is evident from the above-mentioned literature survey that only on undercurrents/plant indicators (*Dakārgala*, chapter 54) of *Bṛhat Saṃhita* is floristically explored partially. There is no information on plants/trees from the other chapters of *Bṛhat Saṃhita* dealing with botanical aspects. Hence, there is a need to publish on the floristic analysis and on the plants and trees that were described in the other five chapters of the *Bṛhat Saṃhita* by Varāhamihira.

Discussion

Bṛhat Saṃhita - The *'magnum opus'*

The *Bṛhat Saṃhita*, a work on various aspects that includes Botany and related features. *Saṃhita* means a collection. It consists of 106 chapters with a total of nearly 4000 *ślokas* (verses). It deals with a large range of subjects, including the movements of planets and their influence on human life, geography, architecture, iconography, omens, manufacture of cosmetics, botany, precious stones and so on. Encyclopedic in character, the *Bṛhat Saṃhita* must have been of immense use to people, particularly to the kings of ancient India, providing guidance in their daily life in respect of many things. It shows the range and wide sweep of Varāhamihira's mind. One can obtain a holistic picture of India of his times from a study of the *Bṛhat Saṃhita* [7, 17, 20].

Among the 106 chapters described in the *Bṛhat Saṃhita*, Varāhamihira designated seven (07) chapters for plants and named them as (1) *Kusumalatā* on flowers and plants (chapter 29), (2) *Indradhvaja* on trees for banner and house building (chapter 43), (3) *Dakārgala* on undercurrents/plant indicators (chapter 54), (4) *Vṛkṣāyurveda* on gardening (chapter 55), *Vanasampraveśa* or *Vanapraveśa* on forest trees (chapter 59), *Gandhayukti* on perfumes (chapter 77) and *Dantakāṣṭha-lakṣaṇa* on tooth-brushes (chapter 85). There are three glossaries of medical and botanical terms in three chapters. Though he intermittently mentioned on Botany and plants in other chapters, but the predominant chapters are the above-mentioned. The *Bṛhat Saṃhita* described various morphologic and physiologic features of vegetation as hydrologic indicators to locate sources of ground water at different depths. Hence, the *Bṛhat Saṃhita* establishes Varāhamihira as the first hydrologist who codified all the then existing knowledge on the subject in his *magnum opus*.

The Hindu calendar

The *Sūryasiddhānta* is a text (of unknown authorship) on astronomy and time-keeping, an idea that appears much earlier as the field of *Jyotiṣa* (*Vedānga*) of the Vedic period. The field of *Jyotiṣa* deals with ascertaining time, particularly forecasting auspicious day and time for Vedic rituals. The *Sūryasiddhānta* is the earliest treatise available on the subject of *Jyotiṣa*. Varāhamihira is credited with thoroughly revising the *Sūryasiddhānta*. He was the first astronomer to furnish a revised version of the Hindu calendar, after calculating the precession of the equinoxes from the period of the preparation of the earlier *Sūryasiddhānta*. He employed *śūnya* or 'zero' as a positive numerical symbol [19].

Kusumalatā on Flowers and Plants

In the Chapter 29th of *Bṛhat Saṃhita* explains on majority of herbs, crops and weed plants with its characteristic feature of the particular plant or tree. There are 14 *ślokas* in this chapter. The floristic analysis is as follows - 45 tree species, 14 shrubs, nine (09) herbs, four (04) cereal crops, five (05) legume crops and two (02) water plants are included. In the *śloka* 1, it describes if the *Śāla* tree (*Shorea robusta* Roth.) should bear fruits and flowers, *kalama* (white rice) will grow in abundance; if the red *aśoka* (*Saraca indica* L.) should bear fruits and flowers red paddy will grow; if the *kṣīrika* should bear fruits and flowers white paddy will grow and if the black *Aśoka* should bear fruits and flowers black rice will grow. In the śloka 2, the growth of the *Nyagrodha* (the banyan tree, *Ficus benghalensis* L.) indicates the growth of yava (barley, *Hordeum vulgare*); the growth of *tinduka* [tendu, *Diospyros malabarica* (Desr.) Kostel.] indicates the growth of the *saṣṭika* rice; and the growth of the *aśvattha* (peepal, *Ficus religiosa* L.) indicates the growth of all crops. In the śloka 3, the growth of the *jambū* [the rose apple, *Angophora costaca* (Gaertn.) Britten] tree indicates the growth of the gingelly and black gram; the growth of *śirīṣa* indicates the growth of the *kaṅgū*; the growth of *madhūka* [mahua tree, *Madhuca longifolia* (Linn.) Macbride] indicates the growth of wheat and the growth of the *saptaparṇa* indicate the growth of the barley. In the śloka 4, the growth of *atimuktaka* [mountain ebony, *Bauhinia variegata* (L.) Benth.] and that of *kunda* (*Cassia* species) indicate the growth of *kapāsa*

(silk cotton tree, *Bombax ceiba* L.), the growth of *asana* indicates the growth of *sarṣapa* [mustard, *Brassica juncea* (L.) Czern.]; the growth of *badarī* (jujube tree, *Ziziphus mauritiana* Lam.) indicates the growth of k*ulattha*, and the growth of *cirabilva* [*Holoptelea integrifolia* (Roxb.) Planch.] indicates the growth of the *mudga* [*Vigna mungo* (L.) Hepper]. In ślokas 5 to 13, several plants, trees and crops were mentioned on their luxuriant growth. It is also explained that there will be good amount rain in those places where trees, shrubs and creepers grow luxuriantly with glossy leaves uninjured by worms, but if the leaves are infested, it indicates that there will be short of rains.

Indradhvaja on Trees for banner and house building

The chapter 43 is described with name Indra's banner (Indra-*dhvaja* or *dhvajastambha*). There are 68 ślokas were described. Matters connected with the fall of the tree, the cutting of it, and with what might be inside the tree have been treated off are described in the chapter on *Indra Dhvaja* and on house-building. It is stated in the śloka 12 that shall not cut any tree growing in flower gardens, in temples, on cremation grounds, on public roads, on sacrificial fire-sites or trees of short growth, or dried trees or trees of stinted growth at the top, thorny trees or trees surrounded by creepers and parasitical plants. In the śloka 13, shall also reject trees with holes in which dwell numerous birds and trees injured by the wind or fire and he shall reject trees of feminine denomination, for all those trees are not fit for the staff of Indra's banner. In the śloka 14, five trees such as (1) *Arjuna* [*Terminalia arjuna* (Roxb.) Wight & Arn.], *Aśvakarṇa* (*Dipterocarpus turbinatus*

C.F.Gaertn.), *Priyaka*, *Dhava* [*Anogeissus latifolia* (Roxb. ex DC.) Wall. ex Guill. & Perr.] and *Uduṃbara* (cluster fig, *Ficus racemosa* L.) are suited for the purpose. Having chosen one of these trees or another well-known tree, or one growing on yellow or black soil, the astronomer shall, alone and at night, approach it and touch it with the hymns.

Manuring, Grafting, Gardening and Plantation

The ancients had a pretty sure knowledge of the fact that the plants derive their food materials from the soil, and they had an excellent knowledge of the science of manuring. The origin of manuring the soil can be traced as early as to a verse of the *Atharvaveda* below:

बभ्रोरर्जुनकाण्डस्यु यवँस्य ते पलाुल्या तिलँस्य तिलपिञ्ज्या।

वीरुत् क्षेँत्रियुनाशुन्यप क्षेँत्रियमुँच्छतु ॥

| *bahrorarju̇nakāṇḍasya yavasya te palāḻyā tilasya tilapi̱ñjyā* |

vīrut kṣetriyanāśanyapa kṣetri̱yamuchatu ‖ - *Atharvaveda* 2-8-3

The above verse explains, "With straw of barley tawny-brown in colour with its silvery ears, with stalk and stem of Sesamum- So let the plague-destroying plant remove inherited disease."

A more elaborate instruction on manuring is found in the *Bṛhat Saṃhita* in the whole chapter 54 is devoted to the purpose known as *Vṛkṣāyurveda*. Thus in *Bṛhat Saṃhita*, "to promote inflorescence and fructification, a mixture of one *adhaka* (64 *palas*) of sesame, two *adhakas* (128 *palas*) of excreta of goats or sheep, one *prastha* (16

palas) of barley powder, one tula (100 *palas*) of beef, thrown into one *droṇa* (256 *palas*) of water, and standing over for seven nights, should be poured round the roots of the plant. The measures given are for one plant. This measure is for all kinds of plants".

Dakārgala - Underground Water and Springs Exploration using Plant Indicators

The term '*Dakārgala*' in Sanskrit connotes 'water exploration'. '*daka*' means water (derived from the Sanskrit word '*udaka*' for water) and '*argalam*', a bolt or bar; i.e., 'a branch of science dealing with water locked up or imprisoned in the bowels of the earth'. The *dakārgala* mentions several indicators to presence of underground water. These are geological, geo-botanical, bio-geological, and non-biological indicators of the surface and sub-surface of the earth that even today could be useful in several regions of India. The other common surface indicators of groundwater, such as termite mounds have also been mentioned [11, 20, 8].

The plants/trees described in the Chapter 54 of *Bṛhat Saṃhita* can also be termed as biological indicator or bio-indicator or phyto-indicator or hydrologic indicators. In other words, plants which indicate some very specific conditions of environment are called plant indicators. The knowledge of relationship between plants and ecological factors can be used as an indicator of environment. Many plants are used as indicators of environment. In a plant community some plants are dominant and found in abundance. These plants are important indicators because they bear full impact of habitat. It has been seen, in general, that plant communities are better indicators than individual plants. Individual plants or plant communities are used to determine the types of soil and other conditions of the environment. Sometimes these also indicate past or future conditions of the environment.

The knowledge of plant indicators can be helpful to determine local soil, thus it can be decided which crops should be cultivated in a particular soil and which soil should be left for pasture or other purposes. Plant indicators are also used to determine optimum use of land resources for forest, pasture, and agricultural crops. Many plants also indicate the presence of particular mineral or metal. So the presence of precious metal can be detected by the growth of the specific plant in an area.

In the Chapter 54, there are 125 ślokas are described. There are 100 species of trees, 15 shrubs, eight (08) herbs, five (05) cereal crops, four (04) legume crops and three (03) water plants.

In the ślokas 63-71, Varāhamihira describes the possibilities of water where ant-hills are present near tender bamboo [*Bambusa arundinacea* (Retz.) Roxb.], *rohitaka* [*Aphanamixis polystachya* (Wall.) R. Parker] trees, Indra trees and golden trees and the quality of water varying from sweet to brackish. Various ecological and environmental interactions are mentioned as indicators of groundwater under the following headings: (a) *phreatophytes* (a plant with a deep root system that draws water supply from near the water table) (b) *phreatophytes* associated with termite mounds, (c) symbiotic inter-growth of trees, i.e. a tree united with another tree species, and morphological, physiological, and mutational features of plants and plant cover (Prasad, 1980). Ślokas 72, 74, 75, 76, 78, 83 and 96 particularly describe the type of trees that show symbiotic
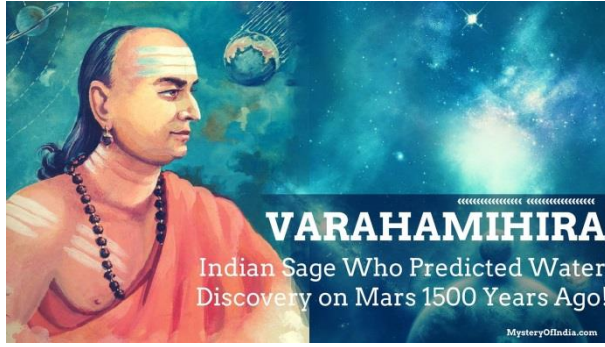
intergrowth and indicate water under the ground. The examples are: *Palāśa* (Flame of the forest, *Butea monosperma* (Lam.) Taubert) and *Badarī* (Jujube, *Ziziphus mauritiana* Lam.), *Bilva* [Wood apple, *Aegle marmelos* (L.) Correa] and *Uduṃbara* (Fig tree, *Ficus racemosa* L.), *Karīra* [Wild caper, *Capparis decidua* (Forssk.) Edgew.] and *Pīlu* (Toothbrush tree, *Salvadora persica* L.) and *Śami* [Indian desert tree, *Prosopis cineraria* (L.)Druce]. An isolated cold spot in a warm ground denotes cold water, while a solitary warm spot in cold ground indicates warm water (śloka 94). A copper-coloured soil mixed with gravel yields astringent water; pale yellow earth is indicative of salt, and a blue soil shows the presence of sweet water (śloka 104).

Springs of water in a woody tract (forest) are situated at a lower level than in open country, and in a desert even lower than in a woody region (ślokas 62, 86, 89 & 93). The appropriate places for digging wells in villages or towns are indicated in ślokas 97 and 98. Construction of embankments for ponds and the shading of the banks by trees are advised by him in śloka 119. Similarly,

Varāhamihira gives a recipe for a substance to be added to water. It is a mixture of *anjana*, *mustā*, *usra*, *rājakosātaka*, *emblic myrobalan* and *kataka* (ślokas 121 and 122). The plant indicators of different soil types that were described in the *Bṛhat Saṃhitā* are presented in the Table 1. The plant communities as ecological indicators for ground water in Indian deserts are elaborated in the Table 2. Varāhamihira suggests the asterisms which are propitious for sinking wells (śloka 123) and ends chapter 54 with comments on exploration for springs [13, 11, 20, 8].

The hydrological indicators documented in ancient India had a scientific basis; applied study is bound to go a long way in satisfying the need for water for irrigation, industrial and domestic use. Varāhamihira documented more than 100 plant species occurring (i) individually, (ii) in association with termite mounds, (iii) in presence of two or three different species together, and (iv) in conspicuous morphologic or physiologic features. With the aid of specific plants, sources of groundwater were located at depths varying from 2.3 to 160 m in different environments of arid and semi-arid regions. Varāhamihira estimated not only the depth of the groundwater but also the distance and direction with respect to the indicator plants [13, 11, 8, 6].

Gardening and Diseases *(vṛkṣāyurveda)*

Table 1: Plant Indicators for Different Soil Types

S. No.	Plant Indicators	Characteristic of Soil
1	*Salvadora oleoides*	High calcium and boron, good soil suitable for crop plants
2	*Zizyphus mauritiana*	Good soil for agriculture
3	*Prosopis cineraria*	Good soil for agriculture crops provided irrigation is available
4	*Peganum harmala*	Soil is rich in nitrogen and salts and good for agriculture
5	*Butea monosperma*	Heavy alkaline soil
6	*Capparis decidua*	Alkaline soil
7	*Rumex acetasella*	Acid grassland soil
8	*Salsola, Suieda fruticosa*	Saline water condition
9	*Andropogon scoparium*	Sandy loan type soil
10	*Argemone mexicana*	Recently disturbed or flooded soil
11	*Phyla nodiflora* and *Rumex* species	Nitrate rich soils
12	*Pinus* and *Juniperus* spp.	Uranium rich soil

There are 31 ślokas described in the Chapter 55. In these ślokas, 66 trees species, 22 shrubs, 11 herbs, six (06) cereals, (03) legumes and four (04) water plants are described. The ślokas from 1-31 suggests gardening trees on the banks of rivers and lakes and other water bodies will be pleasant and agreeable if planted with shady trees. It is therefore necessary to form gardens on the banks of waters. It also describes on controlling the diseases using the same plant material.

Forest Entry (*vanasampraveśa or vanapraveśa*)

In the Chapter 59, there are 14 ślokas described. In these ślokas, 61 tree species, 12 shrubs, 11 herbs, five (05) cereal crops, four (04) legume crops and five (05) water plant species are mentioned. The ślokas from 1-14 suggests on the entry of forests and behavior in the forests inside during the visit. On an auspicious day selected by the astrologer and suited to the master, when the several indications referred to on *Yātra* are all good, the party shall leave for the forest. They shall not cut trees that grow on cremation ground, in

Table 2: Plant Communities as Ecological Indicators for Ground Water in Indian Deserts

S. No.	Plant Communities	Indicated depth of ground-water
1	*Euphorbia caducifolia*	12-18 m
2	*Acacia senegal - Terminalia pendula*	12-18 m
3	*Salvadora oleoides - Tamarix* species	6.0 m
4	*Salvadora oleoides - Prosopis cineraria*	10-20 m
5	*Prosopis cineraria-Zizyphus mauritiana-Capparis decidua*	6.0-18 m
6	*Salvadora oleoides-Capparis decidua*	6.0-12 m
7	*Salvadora oleoides-Zizyphus mauritiana*	18-28 m
8	*Panicum turgidum-Zizyphus complex*	6.0-18 m
9	*Panicum turgidum-Polygonoides calligonum*	6.0-18 m
10	*Crotolaria burhia-Leptadenia pyrotechnica*	6.0-20 m
11	*Suaeda fructicosa-Alurophus lagopides*	6.0 m
12	*Capparis decidua*	12-20 m
13	*Acacia indica-Prosopis cineraria-Salvadora oleoides*	12-20 m

roads, in temples, ant-hills, flower gardens, the abodes of religious devotees, places of worship, junctions of rivers as well as trees grown by human labour. They shall not cut trees that are bent, that are covered with creepers or struck down by lightning or broken by the wind, or that have fallen of them or that are broken by elephants or that have dried or have been burnt or that contain the bee-hive. The trees that are of glossy leaves, flowers and fruits, are fit for the purpose; the tree selected shall be adorned with flowers and duly honoured. If the master is a *Brāhmaṇa*, the trees *Devadāru* [*Cedrus deodara* (Roxb. ex D. Don) G. Don], *Sandal* (*Santalum album* L.), *Śamī* [*Prosopis cineraria* (L.) Druce] and *Madhūka* [*Madhuca longifolia* (L.) Macbride] are fit for the purpose. If the master is a *Kṣatriya*, the trees *Margosa* (*Azadirachta indica* A. Juss.), *Aśvattha* (*Ficus religiosa* L.), *Khadira* [*Acacia catechu* (Linn. f.) Willd.] and *Bilva* [*Aegle marmelos* (L.) Correa] are fit for the purpose. If the master is a *Vaiśya*, the trees *Jīvaka*, *Khadira* [*Acacia catechu* (Linn.

f.) Willd.], *Sindhuka* and *Syandana* should be selected for the purpose; and if the master is a *Śūdra*, the trees *Tinduka*, *Kesara*, *Sarja* and *Arjuna* should be selected. In the formation of the *Liṅga* or an image, the sides of the tree as it grew shall be preserved.

Preparation of Perfumes (*Gandhayukti*)

In the chapter 77 under the category of perfumes, there are 37 ślokas described. There are 22 trees, eight (08) shrubs, 42 herbs, four (04) cereals, two (02) legume species and three (03) water plants mentioned. The beauty items of plant derived products are - flower wreaths, sandal paste, perfumed smoke, clothes and also to blacken and embellish the hair. Ślokas 1 to 6 describes on the beautification of hair and rich perfume baths using plant ingredients. Put into an iron vessel vinegar or the like sour liquor; put in it a quantity of the *kodrava* grain (kodo millet, *Paspalum scrobiculatum*) after removing the husk and iron dust; heat the mixture; grind it well on a stone; rub it over the hair of the head freed from oil; tie over the hair the moist leaves of the green juicy leaves; remain so for six hours. Then remove the mixture from the hair, and rub over them the paste of the fruit of the *āmalaka* (Indian gooseberry, *Emblica officinalis*); cover them with moist leaves as before and remain so for another six hours. Then the hair will become black. Mix together equal quantities of woody *cassia*, *costus*, *Reṇu*, *Nalikā*, *Spṛkkā*, *Tagara*, *Vālaka*, *Keśara* and *Patra* and grind them on a stone forming them into a paste; rub it over the head and then bathe; such a bath is suited to kings. Mix together in oil the powder of *Mañjiṣṭhā*, *Vyāghranakha*, *Śukti*, *cinnamon*, *Kuṣṭha* and *Myrrh*; heat the mixture in the Sun. It is known as *Campakagandhi* oil. In the

śloka 7, it is said to grind together equal quantities of *Patra*, *Turuṣka*, *Vāla* and *Tagara* and the person will get a perfume provoking sexual passion. Add to this perfume *Priyaṅguka* and expose the mixture to the smoke of *Kaṭukā* and *Hiṅgulika*. This will provide perfume which is known as *Vakulagandha*. To this add *Kuṣṭha* and can obtain a perfume known as *Utpalagandha*. Add to this sandal, will become the perfume known as *Campaka-gandha*. Add to this *nutmeg*, *cinnamon* and *Kustumbarī*; and that perfume is known as *Atimuktagandha*. Mix all the above said parts with one-fourth parts of *Śatapuṣpa* and *Kunduruka*, half-parts of *Nakha* and *Turuṣka*, and one part of *sandal* and *Priyaṅgu*; grind them well and expose the mixture to the smoke of *Guḍa* and *Nakha*. This will become an excellent perfume. The ślokas 9 and 10 describes in preparation of other perfumes using various other herbs. Grind together equal quantities of *Jaṭāmāṃsī*, *Vālaka*, *Turuṣka*, *Nakha* and sandal and form a paste; expose it to the smoke of *Bdellium*, *Bālaka*, *lac*, *Musta*, *Nakha* and *Śarkarā*. One part of Harītakī, two parts of Śaṅkha, three parts of Ghana, four parts of Drava, five pans of Ambu, six parts of Guḍa, seven parts of Utpala, eight parts of Śailaka and nine parts of Musta give a perfume. Numerous kinds of perfumes can be similarly prepared by mixing together different parts of each substance in certain combinations using various herbs. These are provided in the ślokas from 11 to 37.

Tooth-brushes (*Dantakāṣṭha-lakṣaṇa*)

In this Chapter 85, nine (09) ślokas are described. There are 12 tree species, three (03) shrubs, four (04) herbs and two (02) cereal crop species mentioned in the ślokas. The

ślokas from 1-9 suggests on the plant twigs that are used as tooth-brushes. It is still being used in the villages of India. The twigs of creepers, bushes, trees, and trees that grow widely can be used to make tooth brushes (*dantakāṣṭha*). A description of all their effects will be long and elaborate. Therefore, it is confined to twigs which are to be chewed to secure certain special ends are mentioned here. It is surprise to know that the there is no mention of the neem tree as a tooth-brush, which is used very commonly in India. Twigs of unknown trees shall be rejected, and twigs with leaves, those of an even number of joints, those which are split or dry at the ends and those with no bark ought not to be chewed. The twigs of *Vikaṅkata* [Madagascar plum, *Flacourtia indica* (N. Burman) Merrill], *Śrīphala* (Indigo, *Indigofera tinctoria* L.) and *Kāśmarī* (*Gmelina arborea* Roxb.) if chewed, will give a person Brāhminical splendour. The *Arka* [*Calotropis gigantea* (L.) R. Br.] twig will increase the splendour of his appearance. The twigs of *Nyagrōdha* (Banyan, *Ficus benghalensis* L.), *Śirīṣa* (*Albizia lebbeck* (L.) Benth.) and *Karañja* [Pongame oil tree, *Pongamia pinnata* (L.) Pierre] if used as tooth-brush will make a person wealthy and prosperous. Those of *Aśvattha* (Peepal, *Ficus religiosa* L.) will make him respected by the people and renowned among his own caste-men. The twig of the *Badarī* (*Ziziphus mauritiana* Lam.) if chewed as a tooth-brush (*dantakāṣṭha*) will make a person healthy; that of the *Bṛhati* (*Solanum indicum* L.) will give him a long life; that of the *Khadira* [*Acacia catechu* (Linn. f.) Willd.] and Bilva [*Aegle marmelos* (L.) Correa] will increase his wealth; that of the *Atimukta* [*Hiptage benghalensis* (L.) Kurz] and *Kadamba*

[*Neolamarckia cadamba* (Roxb.) Bosser] will bring him the object of his desire. The twig of the *Nīpa* if chewed as a tooth-brush will bring wealth to a person; that of the *Karavīra* (Indian oleander, *Nerium indicum*) will bring him good meals; that of the *Bhāṇḍīra* (Bhandira, *Clerodendrum infortunatum* L.) will bring him much food; that of the *Śamī* (*Prosopis cineraria*), *Aṛjuna* [*Terminalia arjuna* (Roxb.) Wight & Arn.] and *Śyāmā* (*Echinochloa frumentacea* Link) will destroy his enemies. The twig of *Aśvakarṇa* (*Dipterocarpus turbinatus* C.F. Gaertn.), *Bhadrataru* (*Trapa bispinosa* Roxb.) and *Cāṭarūṣaka* (*Grewia asiatica* L.) is chewed as a tooth-brush will bring a man self-worth; if chewed the stalks of *Priyaṅgu* [*Setaria italica* (L.) P. Beauvois], *Apāmārga* (*Achyranthes aspera* L.), *Jambu* [*Syzygium cumini* (L.) Skeels.] and *Dāḍimā* (*Punica granatam* L.) will make a person beloved of all people.

Flora of Bṛhat Saṃhita

In the *Bṛhat Saṃhita* different types of plants and trees are mentioned. The flora of *Bṛhat Saṃhita* consists of 545 plant species that are used in medicine, perfumes, gardening and other purposes are described. Also, it is observed that some species of plant names are duplicated in the *Bṛhat Saṃhita* chapters mentioned. Among the 545 plants, 437 species belong to the class Dicotyledonous, 108 species belong to the class Monocotyledonous and one (03) species belongs to the Gymnosperm category, as per the Bentham and Hooker [1] taxonomic system of plant classification. The scientific names of plants are documented as per International Code of Nomenclature (ICBN) from the latest Indian floristic studies and the Royal Botanical

Table 3: Floristic Analysis of *Bṛhat Saṃhita*

Bṛhat Saṃhita Chapter No:	Trees	Shrubs	Herbs	Cereal Crops	Legume Crops	Water Plants
Chapter 29	45	14	9	4	5	2
Chapter 43	5	-	-	-	-	-
Chapter 54	100	15	8	5	4	3
Chapter 55	66	22	11	6	3	4
Chapter 59	61	12	11	5	4	5
Chapter 77	22	8	42	4	2	3
Chapter 85	12	3	4	2	-	-

Gardens, Kew, London. A total number of 522 plant species, belonging to 55 families, includes 311 tree species, 74 species of shrubs and 85 species of herbs. Amongst the 85 herbaceous species, there are 26 species of grasses, 18 legume grain species, 15 other herbs of different families, 17 aquatic plants, two (02) creepers and two (02) oil seed crop species. The chapter-wise floristic analysis of *Bṛhat Saṃhita* is listed in the Table 3.

Conclusions

Thus we have found that different Indian works and traditions contain various observations of plant-life that are scientifically valuable. We cannot but appreciate the keenness of spirit shown in these works. However, this spirit was not rigorously separated from fanciful superstitions and myths. This resulted in no further scientific advances in the study of plants and plant-life. It degenerated from science into an art, and from art into an artifice.

An important contribution of Varāhamihira is the encyclopedic *Bṛhat Saṃhita*. Although the book is mostly about divination, it also includes a wide range of subjects other than prediction. It covers extensive subjects of human interest, including astronomy, planetary movements, eclipses, rainfall, clouds, architecture, and growth of crops, manufacture of perfumes, matrimony, domestic relations, gems, pearls, and rituals. He deals with a dizzying number of subjects in this encyclopedic treatise and gracefully condenses knowledge from all important walks of life for future generations.

The *Bṛhat Saṃhita* could indicate the occurrence of ground water at various depths with the help of different types of plants, trees and grass varieties used as plant indicators. Thus, Varāhamihira is established as the first hydrologist to compile all the knowledge on the subject in his *magnum opus* in the *Bṛhat Saṃhita*. Varāhamihira suggested various biological, pedological, geological, and geophysical characteristics as hydrologic indicators. A critical study of these indicators reveals that they are all primarily the results of the interactions between biotic and abiotic environment due to high relative humidity consequential to the occurrence of ground-

water in arid and semi-arid regions. He described various plant responses, in a ground water ecosystem as hydrologic indicators. This is the most significant aspect of this ancient work is that only those plant responses which are very obvious were employed as hydrologic indicators. These plant indicators are still being used in India by the geologists in identifying water resources.

From the present study, it is evident that the ancient science of gardening, treatment of trees and other aspects of plants/trees which was very much technical in nature. The ancient methodology for treatment of trees shall be helpful for the deep study in further research program in the area of ancient botanical science. The Indian concept of *Vṛkṣāyurveda* may be the real contribution of our ancestors to the intellectual world of science. So, this kind of study is a primary attempt in the light of gardening. The text of *Bṛhat Saṃhita* is creating the new path of research in the area of modern science of treatment of trees and vegetation. Moreover, the implementation of ancient Indian science and technology in the science education is a greater attempt to purify the current curriculum of education. It can be rightly said that *naven anavaṁ śodhayet* meaning "relook the ancient sources of knowledge in modern perspective".

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> Varāhamihira humbly said about his own treatises: "*The science of Astrology is a vast ocean and is not easy for everyone to cross it. My treatises provide a safe boat.*" Truly, even now they are acknowledged as masterpieces.

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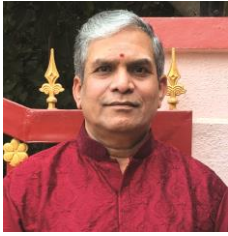
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