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| 8 | NSERIT NAME | | ENGLISH NAME. | BOTANIONL NAME. | HABITAT. |
|-----|-----------------|----|---------------------|---|---|
| 21, | Vişamuşthi | | | Strychnos nux-vo- mica. | Gorakhpur forests. Near Pundua, Orissa, W. Peninsula, Burma. The seeds contain strychnine, an extremely bitter and most poisonous alkaloid. |
| 22 | Karîraka . | •• | | Capparis aphylla | Arid and dry regions of W. Pe- ninsula, from the Punjab and Sind to Tuticorin, waste lands of the Doab. |
| 28. | Sallaki | | | Boswellia se r rata | Sub-himalayan tract from the Sutlej eastwards and throughout the drier parts of the Western Peninsula. Always in decidu- ous forests and often gregarious, forming open forests, C. India, Behar, Chutia Nagpur. |
| 24. | Kåśmarî | | | Gmelina arborea | Sub-himalayan tract from the Chenab eastwards. Aravalli Hills, C. I., Singhbhum, Western Peninsula, Burma, Assam, Cen- tral Bengal, South Lusai Hills, Chittagong. |
| 25, | Páthá | | | Stephania h er nan- difolia . | Sub-himalayan tract from Nepal eastwards, Assam, Khasi Hills, Bengal, Burma, W. Ghats and Coast, Ceylon. |
| 26. | Tindu ka | | | Diospyros em- bryopteris, | Sub-himalayan tract from the Jumna to the Tista, chiefly in ravines and moist shady places. C. I., W. Peninsula, common in Northern Circars, Bengal. The pulp of the unripe fruit is used as gum and in the place of tar for naving the scame of heat. |
| 27. | Vîjasâraka | - | | Variety of Citrus medica. | for paving the scales of boat. |
| 28. | Harîtakî | | | Terminalia chebula | Sub-himalayan tract from the Sutlej eastwards. Common in the deciduous forests. The dry fruit is one of the best tanning materials. (See Brandis' Indian Trees, p. 308, Edition of 1908). |
| 29. | Bhalláta | | Markin g nut | Semecarpus ana- cardium. | Sub-himalayan tract from the Bias eastwards. Assam, Khasi Hills, Chittagong, C. I., W. Pe- ninsula, Behar, Chutia Nagpur, Upper Burma, |

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| 6 | NBERIT NAM | 18, | ENGLISH NAME. | BOTANICAL NAME. | HABITAT. |
|-------------|-------------------|-----|------------------------------|------------------------------------|--|
| 80. | Sampaka. | | | | |
| 51 . | Arks | | | Oalotropis gigan- tea. | Common in the plains of Northern. India and in the Peninsula, Jabalpur, Sundariban, Singh- bhum, often gregarious. Fibre silky, made into rope, paper and cloth. |
| 82. | Puşkara, | | | | |
| 88. | Arimeda | | | Acacia farnesiana | Throughout India and Burma. |
| 84. | Pîtadru | | Variety of plue (Deodar). | | |
| Sõ. | Sálmali | | The cotton tree. | Bombax malabari- cum, | Sub-himalayan tract from the Indus eastwards. Common in both peninsulas and often cul- tivated. |
| 36. | Vibhîta ka | | | T erminalia belle- rica. | Sub-himalayan tract from near the Indus eastwards. Common throughout India and Burma, excepting the arid region of Sind, Western Rajputana and the Southern Punjab. Fruit used for dyeing and tanning. |
| 87. | Naravela. | | | | |
| 38. | Madhuka | ••• | | Bassia latifolia | Planted in most parts of India, propagating itself by selfsown seed. Indigenous in the Sub-hi- malayan tract from the Ravi to the Great Gandak, in the Sat- pura range, and the Peninsula. |

The list of Aranyaka Flora in Sukraniti contains 38 plants. Of these, three have not been identified: (1) Sampaka, (2) Puskara and (3) Naravela. The remaining 35 plants belong to 34 species,¹ as one species has been mentioned in two varieties, e.g., the *Pinus deodara* as Devadaru and Pitadru.

These 34 species are grouped under the following 23 Natural Orders :

| I. | Leguminosæ | | (1) | 'Acacia catechu. | |
|------|------------|------|-----|----------------------|--|
| | - | | (2) | Crotalaria burhia. | |
| | | | (8) | Butea frondosa. | |
| | | | (4) | Acacia arabica. | |
| | | | (5) | Acacia suma. | |
| Sec | | | (6) | Acacia farnesiana. | |
| II. | Verbenaceæ | | (1) | Tectons grandis. | |
| - 10 | | | (2) | Premna integrifolia. | |
| | | a. | (8) | Gmelina arborea. | |
| | | | | | |

" It is to be noted that Vijasûraka mentioned here is a variety of Cilrus medica included in the Brait-bearing list,

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| Bignoniaceæ | | | | Oroxylum indicum. |
|--------------|--|--|---|---|
| Guttiferæ | | | | Garcinia xanthochymus. |
| Dipterocarpa | C888 | | | Shorea robusta. |
| Apocynaceæ | | | (1) | Holarrhena antidysenterica. |
| | | | (2) | Carissa carandas. |
| | | | (8) | Alstonia scholaris. |
| Combretacea | | | (1) | Anogeissus latifolia. |
| | | | (2)- | Terminalia arjuna. |
| | | | (8) | Terminalia chebula. |
| | | | (4) | Terminalia bellerica. |
| Meliaceæ | | | | Cedrela toona. |
| Coniferæ | | | | Cedrus Deodara. |
| Bixaceæ | | | | Flacourtia sapida. |
| Simarubaceæ | | | | Balanites roxburghil. |
| Betulaceæ | | | | Betula bhojapatra. |
| Loganiaceæ | | | | Strychnos nux vomica. |
| Capparidacea | е | | | Capparis aphylla. |
| Burseraceæ | | | | Boswellia serrata. |
| Menispermac | ·9æ | | | Stephania hernandifolia. |
| Ebenaceæ | | · | | Diospyros embryopteris. |
| Rutaceæ | | | | Citrus medica. |
| Anacardiacea | æ | | | Semecarpus anacardium. |
| Asclepiadace | 98 | | | Calotropis gigantea. |
| Malvaceæ | | | | Bombax malabaricum. |
| Sapotaceæ | ••• | | | Bassia latifolia. |
| | Bignoniaceæ Guttiferæ Dipterocarpa Apocynaceæ Combretaceæ Meliaceæ Coniferæ Bixaceæ Betulaceæ Loganiaceæ Capparidaceæ Burseraceæ Menispermac Ebenaceæ Anacardiaceæ Asclepiadace Malvaceæ | Bignoniaceæ Guttiferæ Dipterocarpaceæ Apocynaceæ Combretaceæ Meliaceæ Coniferæ Bixaceæ Bixaceæ Simarubaceæ Betulaceæ Capparidaceæ Burseraceæ Menispermaceæ Ebenaceæ Menispermaceæ Ebenaceæ Anacardiaceæ Asclepiadaceæ Malvaceæ Sapotaceæ | Bignoniaceæ Guttiferæ Dipterocarpaceæ Apocynaceæ Combretaceæ Combretaceæ Coniferæ Bixaceæ Bixaceæ Betulaceæ Capparidaceæ Burseraceæ Menispermaceæ Menispermaceæ Anacardiaceæ Anacardiaceæ Malvaceæ Sapotaceæ | Bignoniaceæ Guttiferæ Dipterocarpaceæ Apocynaceæ Apocynaceæ (1) (2) (3) (2) Combretaceæ Meliaceæ Coniferæ Bixaceæ Simarubaceæ Capparidaceæ Burseraceæ Menispermaceæ Rutaceæ Anacardiaceæ Malvaceæ Sapotaceæ |

(c) Other Plants.

The following is the list of plants to which references have been made in *Sukraniti* either as illustrations or as economic products of daily domestic use, etc.:

| | SANSKRIT NAME. | ENGLISH NAME. | BOTANICAL NAME. | HABITAT. |
|----|--------------------|---------------|----------------------------|---|
| 1. | Utpala, Kamala. | Lotuš | Nelumbium specio- sum. | Large aquatic herb found all over India and extending as far north as Kashmir. |
| 2. | Sarşapa | Mustard | Brassica campes- tris. | Throughout India. |
| 8. | Veņu | Bamboo | Dendrocalamus strictus. | Widely spread and very common throughout India and Burma. |
| 4. | Vrîhi | Rice | Oryza sativa. | Cultivated throughout India. Chief wild habitat from Madras and Orissa to Bengal, Chitts- gong, Assam. Extends to NE- giri Hills, U. P., and even to Punjab. |

¹ See Food Grains of India by A. H. Church (Chapman & Hall, Londou, 1886), The Indian Empire in the Imperial Gazetteer of India Series, Vol. III, Economic, Chapter II (1907). Watt's Dictionary of Economic Products of India, Vols. V, VI (Parts I and II), (142 .)-

| 8. | ANSERIT NAM | B. | ENGLISH NAME. | BOTANICAL NAME. | HABITAT. |
|-----|----------------------------------|-----------|---------------|------------------------------------|---|
| δ. | Ikşa ~ | | Sugarcane | Spitcharum offici- narum. | U. P., Bengal, Punjab. Cultivated throughout sub-tropical and tropical Asia and the islands of the Indian and Pacific oceans. |
| 8. | Tâmbûl a | | Betel léaf | : Piper betle | Oultivated for the sake of its leaves in the hotter and damper regions of India and Ceylon (Madras, C. P., Bengal, U. P., Bombay). |
| 7. | Kuluttha | | Horse gram | Dolichos biflorus or uniflorus. | Wild in the Himalaya to Ceylon and Burma, ascending to 8,000 feet in Sikkim. Not infrequent- ly cultivated. |
| 8. | Maș e | | Black gram | Phaseolus radiatus | Both wild and cultivated through- out the plains. |
| 9. | Mudga | | Green gram | Phaseolus mungo | Both wild and cultivated through- out the plains, ascending to 6,000 feet in the outer ranges of N. W. Himalaya. |
| 10. | Yava | | Barley | Hordeum vulgare | Throughout India. |
| 11. | Tila | | Sesamum | Sesamum indicum | Cultivated throughout the tropi- cal regions of the globe. In India a crop of the warm tem- perate or sub-tropical tracts. |
| 12, | Nişpâpa | | | Dolichos sinensis or lablab. | Wild and cultivated throughout India. |
| 18. | Makuştha | | | Phaseolus aconti- folius. | Throughout India from Himalaya to Ceylon and extending from the tropical region up to 4,000 feet in the N. W. |
| 14, | Chanaka | | Gram | Cicer arietinum | Extensively cultivated through- out India, especially in the Northern Provinces. |
| 15. | Masûra | | Lentil | Ervum lens or Lens esculenta. | Winter crop all over India. |
| 16. | Snuhi | | 1 | Euphorbia ne r iifolia | Wild on rocky ground in C. I., and extensively cultivated in the neighbourhood of villages in Bengal and elsewhere. |
| 17. | Ragona | | Garlic | Allium sativum | Cultivated all over India. |
| 18. | Nill | ••• | Indigo | Indigofera tinc- toria. | Cultivated as an annual or as a biennial or triennial. |
| 19, | Tula (Beng name f Kárpása) | ali or | Cotton | Gossypium herba- ceum. | Egypt, Asia Minor, Northern Africa and Southern Europe, Cultivated at least in N. W. India even as early as Alex- ander. (Watt's Dictionary.) |

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|-----|------|-----|
| • | | , |

| 8 | NSKRIT NAME. | ENGLISH NAME. | BOTANICAL NAME. | HABITA . |
|-----|------------------------------------|--------------------------|---------------------------------|---|
| 20. | Godhuma | Wheat | Triticum vulgare or sativum. | Generally, in those parts of India, where rice does not thrive; but rarely it is culti- vated anywhere south of the Deccan. |
| 21, | Harimatha | Peas | Pisum sativum | Perhaps existed in Northern India before the arrival of E. Aryans. Universal. |
| 22. | Śwetasarśapa, | White mustard or Rye. | Brassica alba | Supposed to be a native of more southern portion of Europe and Western Asia. By no means a common plant. |
| 28. | Gun ja, R ati, Krișņala. | | Abrus precatorius | All along the Himalaya ascend- ing to altitude 3,000 feet and spreading through the plains of India to Coylon and Siam. |
| 24. | Gânjâ | Indian hemp | Cannabis sativa | Wild on the Western Himalaya and Kashmir and acclimatised on the plains of India generally. |

The list consisting mainly of pulses and cereals contains 24 plants belonging to 24 species. The absence of millets and some other cereals is to be noted, but does not prove anything; for the presence of barley in the list indicates the conditions necessary for the growth of all these. The 24 species fall under the following nine Natural Orders :--

| | | | (2) | Phaseolus radiatus. |
|--|--|----------------|----------------------------|--|
| | | | (8) | |
| | | | (0) | Phaseolus mungo. |
| | | | (4) | Dolichos lablab. |
| | | | (5) | Phaseolus acontifolius. |
| | | | (6) | Cicer arietinum. |
| | a. | | (7) | Lens esculents. |
| | .4 | | (8) | Indigofera tinctoria. |
| | | | (9) | Abrus precatorius. |
| | | | (10) | Pisum sativum. |
| 11. | Gramineæ | | (1) | Hordeum vulgare. |
| | 8-9 | | (2) | Dendrocalamus strictus. |
| | | | (8) | Oryza sativa. |
| | | | (4) | Saccharum officinarum. |
| | | | (5) | Triticum sativum or vulgare. |
| III. | Crucifers | | (1) | Brassica campestris. |
| | | | (2) | Brassica alba. |
| . 17. | Nymphaceæ | | | Nelumbium speciosum, |
| V. | Euphorbiace | æ | | Euphorbia neriifolia. |
| VI. | Lillaces | | | Allium sativum. |
| VII. | Piperaces | | | Piper betle. |
| VIII. | Pedalines | | | Sesamum indicum. |
| | Urticacese | | | Cannabis sativa. |
| 111. 1V. V. VI. VII. VII. | Cruciferes Nymphaceæ Euphorbiaceæ Lillaceæ Piperaceæ Pedalineæ Urticaceæ | 8 8 | (1) (2) | Brassica campestris. Brassica alba. Nelumbium speciosum. Euphorbia neriifolla. Allium sativum. Piper betle. Sesamum indicum. Cannabis sativa. |

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SECTION 3.

The Locale of Sukraniti.

1. 'Botanical Statistics' applied to Subrantti.

The Sukra Flora consists of a little above roo plants, of which seven have not been identified. Taking into consideration the varieties, the total number of species in Sukranili is 93 under 40 Natural Orders. Only three of these orders belong to the Monocotyledon class, e.g., Liliaceæ, Palmæ and Gramineæ.

| 1. | Leguminosæ | 18 | species. | 9. | Palmaceæ | 8 | species. |
|----|-----------------|--------|----------|-----|--------------|--------|----------|
| 2. | Urticaceæ | 5 | " | 10. | Sapotaceæ | 8 | " |
| 8. | Rutaceæ | 4 | ** | 11. | Euphorbiaces | -2 | " |
| 4. | Gramineæ | 4 | | 12. | Coniferæ | 2 | |
| 4. | Combretacoæ | 4 | " | 13. | Lythraceæ | 2 | ,, |
| 6. | Verbenaceæ | 3 | " | 14, | Gattiferæ | 2 | ., |
| 7. | Apocynaceæ | 3 | | 15. | Ebenaceæ | 2 | " |
| 8. | Anscardiacess - | 3 | ** | | | | |

The habitats or 'station' of the plants given in the tables in the preceding section indicate a wide range both horizontally and vertically. The 'regions' and 'zones' of the Sukra Flora are thus varied like those of the whole of Indian vegetation. Himalayan, Sub-himalayan, alluvial, riparian, deciduous, evergreen, arid, rocky, and littoral (seacoast), in fact, all the descriptions of Indian Flora have their specimens in Sukrantti. Their vertical distribution also ranges from sea-level to about 3,000 feet high and more. The Sukra Flora thus tells the story of the diverse meteorological, physiographical and geological features of the Indian continent, and may be regarded as more or less epitomical of Flora Indica.

Mally of these plants are cosmopolites, distributed, whether as indigenous or naturalised, throughout the country. Except the Pinus longifolia (sarala) which is characteristic of Himalayan Flora, the Santalum album which is characteristic of South India, and the Palmæ of the hot and humid regions, the Sukra Flora does not seem to contain any characteristically local or provincial specimens. If we add to these the fact that as articles of commerce for the necessaries, medicines, arts, industries, comforts and luxuries of life most Indian plants have been known in all parts of India since very early times,¹ we can realise the difficulty of characterising the Sukra Flora as belonging to a particular area on the strength of the 'statistics' and 'physiognomics' of plants, and thus of ascertaining the 'locale' of *Sukraniti* from a study of the geography of its flora.

The small percentage of Monocotyledons in proportion to the Dicotyledons indicates lower latitude and absence of great cold. This is according to the

¹ The Char.ska Samhila, a medicinal work of the Pre-Buddhistic times, written certainly in the Punjab, mentions Santalum album. Roxburgh in Flora Indica (1974) notes the inxuriant growth of the plant in Calcutta Botanical Gardens (p. 148).

reckonings of Humboldt' who determined after laborious processes that "in the torrid zone the monocotyledons are as r: 6 to the Dicotyledons, while in the temperate zone the proportion is i: 4, and in the arctic i: 3." This delimitation of area, however, is too wide, as it gives only one general term 'equatorial' for the distribution of the Sukra Flore.

From the statistics of the species and Natural Orders, however, we can generalise, though still within wide limits, as to the Geography of the Sukra Flora more satisfactorily than above. For most of the species in the Sukra Flora may be allotted to the sub-tropical zone, the botanical characteristics of which are given below :" "In the sub-tropical zone the vegetation is green throughout all the year like the forests of the damp regions of the torrid zone. From the great heat of the sun palms as well as bananas grow here in the plains. • • The date-palm belongs to the whole western part of the sub-tropical zone of the old world. * * * In summet* there is a tropical heat which ripens almost all the fruits of the equatorial zone, while in winter the temperature is so low that often old trees of the well-known noble tropical fruits perish. During the summer which is here at the rainy season there are cultivated rice, indigo, cotton tree, &c.; of leguminosæ, species of phaseolus and dolichos ; gourds, sesamum, &c.

But the appearance of the inhabited districts of this country is totally different in winter when the cereals of the north are cultivated such as wheat, barley, oats, millet, and also beans, mustards, &c. But the vegetation of the uncultivated places as well as of the cultivated soil exhibits these different characters at the different seasons; that is, in summer it resembles the vegetation of the warmer zones. In winter, on the contrary, only old well-known genera belonging to the colder part of the temperate zone appear. * * The chief plants which in summer adorn the district round Delhi with a more southern character, are Dalbergia sissoo, Acacia setissa, arabica, farnesiana, Cedrela toona and various species of Melia, Ficus, Morus, Gmelina, Phœnix, &c."

This diversity of vegetation according to seasons of the year would well explain the wide differences in the habitation of the plants in Sukraniti we have referred to at the beginning. The following general description of the physiognomy and topography of the countries of the sub-tropical zone, also, fits in very well with the varied physiography suggested by the Sukra Flora:—" In- all the plants we have named we perceive a receding from the equator; there is no longer a trace of the excess of tropical forms; but so beautiful a country, the climate of which unites the advantages of the torrid and temperate zones, will in the possession of an active nation, soon become the rendezvous of all the cultivated plants of the various zones, and even now there is grown there a variety of the

¹ Meyen Botanical Geography (1846), pp. 278-79.

^{*} Meyen's Botanical Geography (1846). pp. 177 etc. The country round Delhi and from Delhi to Serampore on the Hooghly has been taken as typical of the sub-tropical zone.

beautiful fruits of the torrid and temperate zones, such as hardly any country can boast of,"

Thus gradually narrowing the boundaries we come to the conclusion that the Flora of the sub-tropical zone may well cover the whole of Sukra-Flora. We have to note also that the chief characteristic of this zone, as of the Sukra Flora, is the double aspect according as the summer or winter vegetation is most fully displayed.

In order to find out more closely the locale of this vegetation in India it now remains to apply or interpret the above hypothetical generalisation about Sukra Flora according to the facts and conditions of Indian Phyto-geography. We therefore proceed to enquire into the regions and sub-regions of India, botanically considered, according to (1) ecological evidences and (2) literary evidences. We shall then be in a position to demonstrate (1) how far the subtropical theory is tenable and (2) which portions of this zone are indicated.

For the ecological evidences we should have to take a broad survey of Indian Botanical Geography and study the chief provinces or divisions into which the country may be divided according to the predominent types of vegetation brought on by the conditions of soil, physical features, environment and climate, &c. In the second place, the Sukra Flora would have to be allocated in one or other of these botanical provinces. The hypothesis about the sub-tropical character of the Sukra Flora would thus be incidentally verified.

For literary evidences we require a historic survey of Indian literature. The objects are :--(1) to trace the influence of topographical and botanical conditions on the literary activities of ancient and mediaeval scholfars, e.g., to detect any clues as to the local character of the botanical references by Indian authors, and (2) to compare, contrast or connect the Sukra Flora, if possible, with the important Floras celebrated in Indian literary history, e.g., Vedic, Paņinian, Charakan, Buddhistic, Kalidasic, Amarasimhan, Varahamihiran, Tantric, Pauraņic, and so on, as regards geographical affinity or otherwise.

2. Ecological Evidences.

In the following summary of the characteristics of Indian Botanical Geography we are giving a synopsis of the classical remarks of Dr. Hooker and Dr. Thomson in the celebrated *Introductory Essay* to their monumental *Flora Indica*. "From the position of India, its climate (and hence its vegetation) is more generally tropical, than the latitude under which so much of it is included would alone indicate. The mountains, however, when above 4-5,000 feet everywhere present more or less of a temperate vegetation which becomes wholly temperate at greater elevations and which passes into an alpine flora over a large extent of still loftier mountain country."

The tropical character is thus the most general feature of Indian vegetation. "The general physiognomy of the greater part of the Indian Flora probably approximates more to that of tropical Africa than to any other part of the globe, accompanying in both cases immense alluvial plains, bounded by deserts at certain points and traversed by mountian chains of moderate elevation."

The vegetation, however, does not present a dead uniformity, but is richly diversified in aspect. Thus

(i) the impenetrable green jungles of Eastern Bengal, and the west coast of the Madras Peninsula contrast strongly with the drier parts of the intertropical zone, and still more so with the loosely-timbered districts of Central India and of the base of the Western Himalaya.

(2) The tropical forests may be divided into (a) those which inhabit perennially humid districts and (b) those which are confined to regions presenting contrasted seasons of summer rain and winter drought.

(3) The third circumstance which contributes to diversity in Indian Flora is the peculiar protean climate of the extra-tropical regions. These unite within themselves by a change of seasons the conditions of both tropical and more or less temperate floras. This holds true not only with regard to forest vegetation, but also with regard to annuals and perennially rooted plants with annual stems. The intrusion of tropical floras upon extra-tropical regions and lofter mountain valleys in summer, and the appearance of annual plants of the north temperate zone in the extra-tropical regions during the cold months are causes which greatly modify the vegetation of India in general aspects and character.

Now, taking the more fundamental climatological forces into view, the whole of India may be regarded as constituting only one Botanical area, subdivided for ordinary (and less scientific) purposes into tropical and sub-tropical. This is practically what Hooker and Thomson did in the *Introductory Essay* in 1855; in which, to quote from Brandis' *Indian Trees*, ¹ "four primary divisions were recognised, viz. i. Hindustan including the Western Peninsula from the base of the Himalaya to Cape Comorin; ii. The Himalaya; iii. Eastern India or India east of the mouth of the Ganges; and iv. Afghanistan and Baluchistan."

The same thing has been done, though under slightly different names, by Hooker in the chapter on Indian Botany in Vol. I of the *Indian Empire* of the Imperial Gazetteer Series (1906). To quote Brandis, again, "In this admirable paper. Hooker divides British India primarily into three Botanical areas, a Himalayan, an eastern and a western, the two last-named being roughly separated by a line drawn meridionally from the Himalaya to the Bay of Bengal. These areas he divides into the provinces, *viz*, (1) The Eastern Himalaya, (a) The Western Himalaya, (3) The Indus plain, (4) The Gangetic plain, (5) Malabar in a very broad sense, (6) The Deccan in a very extended aense, (7) Ceylon, (8) Burma and (9) Malaya Peninsula."

It is in one or other of these Botanical provinces that we have to seek the types represented by the Sukra Flora.

The chief difficulty arises from the fact that, though "each one of these is distinguished from the others by the possession of some characteristic forms

¹ Pp. XV. xvi (Edition of 1906).

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of vegetation and more especially by the general aspect and constitution of its flora, it must not be assumed ¹ that all the species of a botanical province are to be found nowhere outside its geographical limits. On the contrary, the characteristic vegetation of one province passes by insensible gradations into that of another, so that, owing to the absence of any sharply defined limits, their boundaries cannot be considered as more than approximative."

(A) Gujrat Flora and Sukra Flora.

If individual species or orders are considered, the Sukra Flora may be more or less wholly located within parts of almost each one of these provinces.

Thus in the list of Gujrat Trees compiled in Vol. XXV of Gazetteer of the Bombay Presidency (1886), we get the following specimens of the Sukra Flora :

(a) Fruit Trees.

1. Mangifera indica. 2. Bassia latifolia. 3. Tamarindus indica. 4. Zizyphus jujuba. 5. Feronia elephantum. 6. Ægle marmelos. 7. Carissa carandas. 8. Diospyros melanxylon. 9 Cirrus medica. 10. Punica granatum. 11. Morus indica. 12. Anona reticulata. 13. Cocos nucifera. 14. Areca catechu. 15. Musa sapientum.

(b) Flowers and Flowering Trees.

1. Michelia champaka. 2. Bombax malabaricum.

(c) Timber Trees.

1. l'ectona grandis. 2. Dalbergia sissoo, 3. Gmelina arborea. 4. Acacia arabica. 5. Anogeissus latifolia.

(d) Aroma and spice-producing Trees.

1. Santalum album, 2. Boswellia serrata.

(c) Dye pigment and Tan-yielding Trees.

1. Butea frondosa. 2. Acacia catechu. 3. Terminalia bellerica 4. Woodfordia floribunda.

(f) Other useful Trees.

1. Holarrhena antidysenterica. 2. Dendrocalamus strictus.

(g) Liquor yielding Trees.

1. Phœnix sylvestris

(h) Shade Trees.

1. Terminalia arjuna. 2. Ficus glomerata. 3. Ficus religiosa. 4. Eicus bengalensis. 5. Pongamia glabra. 6. Azadirachta indica.

(i) Miscellaneous Trees.

1. Balanites roxburghii.

(j) Hedge Plants

1. Euphorbia neriifolia.

' Remarks about the Flora of the Bombay Presidency (divided into five Botanical Provinces) by Dr. W. Gray.

In the above list we have altogether 39 species, out of 93 in the Sukra Flora. As the Gujrat list does not contain the cereals, pulses and other foodgrains we have to deduct at least 24 from the Sukra list for purposes of comparison. The result is that above half of Sukra Flora is represented in Gujrat, an area which, according to the Botanical divisions of Hooker, falls within two provinces, the Indus plain and Malabar.¹

(B) Bengal (Gangetic Plain) Flora and Sukra Flora.

Exactly the same may be said with greater force about the plants of Bengal, also, which forms the humid region of the Gangetic delta and the region immediately north of it, constituting the southern sub-region of Hooker's Botanical province of the Gangetic plain. "The villages' are usually buried in groves of mango, figs, and bamboos, with the betel-nut, palm, palmyra, phoenix and cocoa-nut." "The indigenous flora is much more extensive than that of the upper Gangetic plain, comprising' all the species which grow there (except those belonging to the Egyptian or arid flora), besides many others which are not found to the north-west."

Now this inclusion of Upper Gangetic Flora within the area of Bengal means practically the inclusion of all the characteristic floras of India. For, according to the Introductory Essay, "If we exclude this dry country flora, which just skirts the southern part of the plain, the vegetation of the Gangetic plain presents few peculiar features; indeed a catalogue of the plants of Rohilkband contains very few species which are not common all over India, even to the extreme south of the peninsula, in those provinces which have a similar climate, * * We have already had occasion to direct attention to the remarkable uniformity of the vegetation over large areas of India, and as our information becomes more precise, the sameness becomes more striking."

These circumstances lead to Bengal Flora being more copious, varied and epitomic of India, comprising (1) not only the characteristic vegetation of humid regions like portions of Gujrat, but also (2) the species that are more or less uniformly distributed over the whole of India, excepting only the peculiar vegetation of arid regions. The result is that Bengal alone can supply a greater percentage of the Sukra Flora than Gujrat or other areas having more or less the climate of Bengal type.

And if following Botanical Geographers, we take Bengal proper along with the other sub-regions of the Gangetic provinces as one Botanical Region,

¹ See Imperial Gazetteer, Indian Empire, Vol. 1, p. 163.

² Indian Empire in the Imperial Gazetteer of India, Vol. I, 188.

[•] Introductory Essay to Flora Indica by Hocker and Thomson, p. 165; see also Records of the Botanical Surrey of India, Vol. III, No. 2. "The Vegetation of the districts of Hughli, Howrah and 24-Pergunnahs" by D. Prain (1905). It is interesting to learn that, of the 69 species in the two lists of Sukra Flora, 44 are to be found in these two districts of Bengal alone. Cf. the lists of plants in the introductory section on Topography and Vegetation (pp. 149-168). As for the cereals and other plants, the whole Sukra Flora is represented in this small enough area.

the whole of the Sukra Flora including, as it does, the deciduous, evergreen, riparian, arid, littoral, humid and other species can be without the least difficulty located in this habitat, which has an extensive area, slightly diverse geological character and the characteristic round of seasons. For this Gangetic plain¹ comprises (1) an upper region including Rajputana east of the Aravalli Hills, Bundelkhand, and Malwa north of the Vindhya range and (2) a lower, including Bengal south of the Himalayas, Orissa north of the Mahanadi, the Assam, Sylhet, Cachar, and Tippera plains

(C) South Indian Flora and Sukra Flora.

About the vegetation of Southern India we summarise below the remarks of Hooker and Thomson in the Introductory Essay: "From the humid character of the Malabar climate, its luxuriant vegetation might be inferred. Hamilton tells us that it resembles Bengal in verdure, but has loftier trees and more palms ; the shores are skirted with cocoanuts, and the villages surrounded with groves of betel-nut, palms, &c. * * * The low valleys are richly rothed with rice-fields and the hill sides with millets and other dry crops. whilst the gorges and slopes of the loftier mountains are covered with a dense and luxuriant forest. The mass of the flora is Malayan, and identical with that of Ceylon, and many of the species are further common to the Khasia and the base of the Himalaya.* * • The whole Concan is more open than Malabar, heavy forests are rarer, many tropical Malayan forms disappear.* * * The arid flora of the Deccan, of Marwar and Sind, however, hardly enters the Deccan.^e • • As a whole the vegetation of Carnatic is neither rich nor varied. The climate being very arid except during the north-east monsoon. the humid flora is entirely absent.* * * The climate of Mysore is much drier than that of Malabar.* * * The vegetation of Mysore, like that of the Carnatic, is rather scanty. The level surface of the tableland is frequently very barren, and the hills are often bare or covered with low scrubby jungle.** The vegetation of the plain of the Deccan is not very different from that of Mysore. The flora is not extensive, the great drought of the bot season being unfavourable to vegetation."

We have here the botanical features of two of the nine provinces enumerated above comprising about the whole of South India:⁹

(1) Malabar in a very extended sense—the humid belt of hilly or mountainous country extending along the western side of the peninsula from Southern Gujrat to Cape Comorin; and (2) the Deccan in a very broad sense; i.e., the whole comparatively dry tableland of the peninsula east of Malabar and South of the Gangetic and Indus plains together with the Coromandel Coast.

As might be expected, such an extensive area with so diverse botanical features as to constitute two great provinces would be able to make a decent

^{&#}x27; Chapter IV, Botany in Indian Empire, Vol. I.

[&]quot; Indian Empire in Imperial Gezetteer, Vol. I, p. 168.

show of the specimens included in the Sukra Flora. As a matter of fact, a comparison of the Sukra list with the lists for these two provinces in the Botanical volume of the Bombay Gasetteer as well as the chapter on Botany in the Imperial Gasetteer, would show that almost all of the Sukra Flora have their homes in this whole region taken together. And yet the total strength of the South Indian Flora, even supposing that so varied characteristics can be given to any one type, does not probably come up to that of Bengal (singly considered), and not certainly to the whole Gangetic plain (including Bengal) described above as a really single Botanical area.

So far as the Sukra Flora is concerned, the following specimens seem to be rare in the South:

- (1) Feronia elephantum (wood apple).
- (2) Minusops hexandra (rajadana).
- (3) Pyrus communis (pear tree, amrita).
- (4) Pinus longifolia (sarala, pine).
- (5) Juglans regia (aksota, walnut).
- (6) Phylanthus distichas.
- (7) Myrica sapida (kāsthāmra).
- (8) Diospyros melanxylon (kuddåla, ebony).
- (9) Premna integrifolia (agnimantha).
- (10) Cedrus or Pinus deodara (devadaru, Himalayan cedar).
- (11) Flacourtia sapida (vikankata).
- (12) Betula bhojpatra (bhurja)
- (13) Boswellia serrata (sallaki).
- (14) Stephenia hernandifolia (patha).
- (15) Diospyros embryopteris (tInduka).

In the above list of 15 species, the (1), (2), (6), (11), (14) and (15) are not entirely absent from South India. The other nine are conspicuous by their absence. The two Pines, longifolia and deodara, Juglans regia, Pyrus communis, and the Betula bhojapatra are essentially Himalayan, and hence belong to the North Indian type. The remaining four are mainly Sub-himalayan and have their habitats generally in the dry deciduous forests of North India.

(D) Indus Plain Flora and Sukra Flora.

The absence of the characteristic Himalayan and North Indian species in the southern regions or sub-regions, taken separately or together, is a strong proof against the Sukra Flora being of the southern type. Similarly, we have to exclude the Indus plain, a Botanical province of North India, also from claiming the locale of the Sukra Flora. For though the area is wide enough including the Punjab, Sind and Rajputana west of the Aravalli range and Jumna river, Cutch and Northern Gujrat, and repeats the vegetation of the Sunderbans at the Indus delta, the flora is less copious and richly diversified and presents essentially the features of arid, deciduous and desert vegetation. The result is, that some of the more important specimens in Sukra Flora which are to be found in humid Gujrat and Bengal are entirely absent from this province.

The determination of the geographical limits of the Sukra Flora, positive and negative, has been guided by both meteorological and botanical considerations. We have had to find out some one province from among the large Botanical Provinces of India, which satisfies both the following double sets of conditions:

- (1) A meteorological area which possesses both humid and arid characteristics, and
- (2) a botanical area which can command both Himalayan and plain floras.

The first condition can be fulfilled by either the northern or southern region. For, meteorologically' speaking, there are two moist regions in India: (1) the western moist region extending from the Gulf of Cambay, and (2) the eastern moist region comprising the Eastern Himalaya with a narrow strip along the outer ranges extending north-west as far as the Ravi &c Any one of these moist regions together with a neighbouring dry and arid region, eg., the Peninsular (Deccan), and the area including Eastern Rajputana, a large part of United Provinces up to Cawnpur, &c, can well be the home of the Sukra Flora.

But the second test cannot be fulfilled except by a northern region, as we have seen above.

Hence, by a process of elimination, we get the northern (as well as eastern) moist region together with a neighbouring arid region, e.g., Eastern Rajputana as the natural habitat of the Sukra Flora. The Indus Plain among the nine Botanical Provinces of Hooker is thus excluded as a matter of course; the remaining portion of Northern India covering exactly the whole of the Gangetic plain, with its upper dry and lower humid regions described above, is the home of the Sukra Flora.

It may be remarked here that this Botanical Province corresponds also to the sub-tropical zone $(23^{\circ}-34^{\circ})$ latitude) determined independently by the application of 'Botanical Statistics' to the Sukra Flora.

3. Literary Evidences.

The consideration of literary evidences would necessarily lead to a historic treatment of the knowledge of Flora displayed by the makers of Indian literature. Such a study is expected to yield not only a Botanical Geography of India defining within approximate limits the locale of the authors and their compositions, but also a Botanical History of the country giving the approximate periods

¹ For these meteorological divisions, see Brandis' Introduction to his Indian Trees, p. xvii.

during which certain plants began to be cultivated and naturalised in different parts of India, whether as imports from province to province or as exotics¹ from altogether alien soils. A history of Indian Botany like that of Indian Mineralogy is thus likely to solve some important questions of Indian Chronology, as they are really parts of the larger history—that of Indian economic as well as political life and institutions.

But, unfortunately, the landmarks of Indian literature, Vedic, Epic, Pauranik, Tantric, Buddhistic, &c., have not undergone that analytical study which may enable one to form an estimate of the progress of the Indians in the knowledge of plants and plant-life. Nor have even individual authors like Paņini, Charaka, Valmiki, Kalidāsa, and others been so thoroughly and searchingly studied. The present attempt is, therefore, purely suggestive or tentative, and not at all exhaustive in any sense.

There are, however, two things which should be specially borne in mind in any study of literary evidences:

(1) we have to be perpetually on our guard against the fallacy of argumentum ex silentio; and

(2) we have to discriminate between what is purely a conventional mention or a reference to the permanent stock-in-trade preserved in floating literature which does not admit of any anachronisms and limitations of space, and what is the actual description of the sights and sounds or facts and phenomena in the locality or the region of experiences familiar to the author.

The errors arising from a neglect of these two conditions cannot, however, be easily avoided in the present state of our knowledge regarding things Indian, both physical and human.

A.-Vedic Flora and Sukra Flora.

The Atharva Veda is famous for its references to, and hymns about, plants. The usefulness of Flora is known by the reciters of the hymns in the following respects, e.g., against injury and disease and obstruction of urine (I, 2, 3), against leprosy (I, 23), as a love-spell (I, 34), against curses and cursers (II, 7), for victory in disputation (II, 27), against a rival wife (III, 18), for recovery of virility (IV, 4), to heal serious wounds (IV, 12), against witchcraft, and to discover sorcerers (IV, 18, 20 and V, 14, 15), against various evils, enemies and super-human foes (IV, 17, 19, 37), against fever (V, 4), to win and fix a man's love (VII, 38) against a (woman) rival (VII, 113), etc.

The following extracts give a few specimens of the floral lore in the Atharoa Veda :-

"The berry (pippali)" remedy for what is bruised, and remedy for what is pierced—that did the gods prepare; that is sufficient for life."

¹ For an account of some of these importations from Central Asia, Africa, China, Malaya, America, &., see Prain's Vegetation of the Districts of Hughli-Howrah and 24 Pergunnahs (1905) in the Records of the Botanical Survey of India, pp. 162-166.

² Harvard Oriental Series, Vol. 7, p. 859.

"Since thou, O off-wiper (apamarga), hast grown with reverted fruit, mayest thou repel from me all curses very far from here."

The amulet of udumvara* bestows various blessings :-

"Rich in manure, rich in fruit, swadha and cheer in our house-prosperity let Dhatar assign to me through the keenness of the amulet of Udumvara. ** I have seized all the prosperity of cattle, of quadrupeds, of bipeds, and what grain (there is); the milk of cattle, the sap of herbs, may Brihaspati, may Savitar confirm to me. * * * As in the beginning, Thou, O forest-tree wast born together with prosperity, so let Saraswati assign to me fatness of riches."

The darbha plant is thus described :-

"Hundred-jointed, hard to be stirred, thousand-leaved, uplifting(?)-the darbha that is a formidable herb, that I bind on thee in order to (prolong) life-time. * * * In the sky is thy tuft, O herb; in the earth art those set; with thee that hast a thousand joints, do we increase further our life-time."

The efficacy of the following herbs also is most eloquently dwelt uponjangida (XIX, 34, 35), satavâra (XIX, 36), guggulu (XIX, 38), kuştha (XIX, 39).

The aśwattha is invoked against enemies (111, 6) and the śami for benefit to the hair (VI. 30). The land is known to be the mother of healing plants: " "These three earths (prithivi) that are there—of them earth (bhûmi) is the highest; from off their skin have I seized a remedy."

The following is the hymn sung by Viswamitra for the increase of barley:⁵

- "1. Rise up, become abundant with thine own greatness, O barley; ruin all receptacles; let not the bolt from heaven smite thee.
 - 2. Where we appeal unto thee, the divine barley that listens, there rise up, like the sky; be unexhausted, like the ocean.
 - 3. Unexhausted be thine attendants, unexhausted thy heaps; thy bestowers be unexhausted; thy eaters be unexhaused "

The following plants are common to Sukraniti and Vedic Literature:⁶ Ficus religiosa, (2) Ficus glomerata, (3) Zizyphus jujuba, (4) Gmelina arborea, (5) Butea frondosa, (6) Acacia catechu, (7) Phœnix sylvestris, (8) Pinus deodara (9) Ægle marmelos, (10) Flacourtia sapida, (11) Acacia suma, (12) Bombax, malabaricum, (13) Dalbergia sissoo, (14) Diospyros embryopteris (15) Ficus bengalensis.

• For references to plants in Vedic Literature, see Vedic Index, Vol. II, p.590. See also Macdonell's Sanskrit Literature (1900), pp. 145-146, and Mr. Bijaychandra Majumdar's Vedic Names of Plants in the Kartik number of the Bengali monthly, Bharati (Calcutta, 1913.)

^{&#}x27; Ibid, Vol. 7, p. 482.

² Atharva Veda (Harvard, Vol. 8), pp. 944-46.

¹ Ibid, pp. 947-950,

[&]quot; Harvard Oriental Series, Vol. 8, p. 295.

^{*} Ibid, Vol. 8, p. 887.

Of these some are Himaiayan species, some are common all-India cosmopolites, and others belong to the more or less dry and arid regions. The Vedic Flora thus indicates the marks of the Indus plain region and the upper Gangetic plain. So far as Sukra Flora partially coincides with Vedic Flora, the common geographical influences must be responsible for this. We have seen above that this area is a part of the larger region covered by the Sukra Flora.

(B) Charaka Flora and Sukra Flora.

Among the fruit-bearing plants, the following species are common to Charaka Samhitā¹ and Sukraniti: (1) Ficus glomerata, (2) Tamarindus indica, (3) Santalum album, (4) Citrus medica, (5) Nauclea cadamba, (6) Jonesia asoka, (7) Ægle marmelos, (8) Feronia elephantum, (9) Mimusops hexandra, (10) Mangifera indica, (11) Calophyllum inophyllum, (12) Michelia champaka, (13) Phœnix sylvestris, (14) Pinus longifolia, (15) Punica granatum, (16) Juglans regia, (17) Zizyphus jujuba, (18) Azadirachta indica, (19) Myrica sapida, (20) Mimusops hexandra, (21) Pongamia glabra, (22) Areca catechu.

Among the *áranyaka*, the following species are common to *Charaka* Samhilâ and Sukraniti : (1) Acacia catechu, (2) Premna integrifolia, (3) Shorea robusta, (4) Holarrhena antidysenterica; (5) Anogeissus latifolia, (6) Butea frondosa, (7) Alstonia scholaris, (8) Cedrela toona, (9) Cedrus deodara, (10) Carissa carandas, (11) Balanites roxburghii, (12) Boswellia serrata, (13) Gmelina arborea, (14) Stephania hernandifolia, (15) Diospyros embryopteris, (16) Terminalia chebula, (17) Semecarpus anacardium, (18) Calotropis gigantea, (19) Acacia farnesiana, (20) Bombax malabaricum, (21) Terminalia cellerica and (22) Bassia latifolia.

In the above two lists we have 44 species of the 69 in the Sukra Flora, *i.e.*, above 60 per cent. A careful enumeration of all plants in *Charaka* would show a higher percentage. In fact, it would not at all be erroneous if we assert that perhaps the whole of the Sukra Flora is included in the Charaka list of 500 plants divided into 50 pharmacopocial vargas or orders of 10 each. It is not safe to define the geographical horizon of the Charaka Flora, at any rate it is certain that, unlike the Vedic Flora, it cannot be assigned solely to the Indus or the Upper Gangetic plain. *Cocos mucifera* does not seem to be included in the list, but Areca catechu is there, and this unmistakably points to humid, deltaic or littoral vegetation.

This extension of the Charaka Flora beyond the limits of the Punjab, the home of the first authors of the Charaka cycle, indicates that the whole of Northern India at any rate, if not portions of the South, must have been known from sea to sea. Regular trade in medicinal herbs, cultivation or naturalisation of those that are not indigenous, systematic exploration of forests on hills and in plains, and such like things that take Ayurvedists and druggists out of the limits of any one botanical region and make them more or less cosmopolitan,

¹ Bar the names of plants in Charaka Samhita, see the Marathi work on the Fegetable Flora of India by Dr. Pandurang Gopal (Poons, 1886),

are implied in the scientific analysis and classification of the vegetable materia medica in the text-book of the Punjab masters.

It must be noted also that the possibility of merely hearsay or conventional references and descriptions of things not personally observed or experimented upon is not unlikely, though it would be well-nigh impossible to assert this dogmatically about one or other of the Charakans, Susrutans, Vagbhatans, and Chakradattans. Certain it is that in the latter-day schools of medicine the lists became more and more conventional, mere reproductions from the writings of the great masters or Risis. There is, however, another important point with regard to the lists of Flora in the successive commentaries or abridgments of the medical encyclopædias. A comparative study' of the Indian Pharmacopæias would show that Vagbhata, Chakradatta. Narahari Pandit and Bhava Misra, while perpetuating the tradition of their great precursors, have introduced not only new names but also new plants in the treatises prepared respectively for Western India, Eastern India, Maharastra and Madhyadesa. While therefore, we admit the existence of a conventional floating literature on medicinal plants as on other things, which, like a touch of nature converted the whole of India into a single unit, a common home of the men of letters, and imparted a family likeness and universal or all-India character to the literary productions of educated Hindusthan, we cannot rationally ignore in them the possession, also, of a local colour and provincial physiognomy which can be detected only by the patiently investigating eye of skilful observers.

So far as the Sukra Flora is concerned, we see that its geography is more extensive than that of the Vedic, but less than or perhaps equal to, that of the Charaka. If we notice the flora in points which make them differ, we find that the Vedic and the Charaka are more Himalayan, while the Sukra is more humid.

(C) Varáha Flora and Sukra Flora.

In the Brihat Samhilâ of Varâhamihira, botanical facts and phenomena have been recorded in three chapters. The 29th chapter deals with flowers and plants and is called Kusumalatâdhyâya. The 54th is called Dagârgala and deals with under-currents, both good and evil, which may be indicated by the position and growth of plants as well as by other things. The 55th chapter treats of gardening and horticulture and is named Brikşâyurveda. The plants mentioned in these three chapters may be taken to be those most familiar to the people of Avanti (in Ujjayini) in the 6th century A.D., for that is the birth-place of Varâha. It may be possible to find out the Geography of the Sukra Flora by comparing the lists furnished in Brihat Samhitâ about the Ujjayini Flora with those in Sukrantti.

¹ Materials for such a comparative study have been furnished by Kaviraj Birajacharan Gupta of Ocochbehar State in the two volumes of the Bengali work, Vanaugadhidarpana, and also in his learned introduction to them.

Among the trees mentioned by the Sukra authors as *phalinah* or fruitbearing, almost all are referred to by Varâhamihira. Only the following 16 species appear to be special to the Sukra Flora: (1) Tamarindus indica, (2) Santalum album, (3) Citrus medica, (4) Pyrus communis, (5) Myrica sapida, (6) Morus alba or Morus indica, (7)Spondias mangifera, (8) Pinus longlfolia, (9) Juglans regia or aleurites moluccana, (10) Mimusops hexandra, (11) Pongamia glabra, (12) Garcinia xanthochymus, (13) Diospyros melanxylon, (14) Phyllanthus distichas or Anona reticulata, (15) Areca catechu, and (16) Cocos nucifera.

Here also one must not be blind to the *argumentum ex silentio*. Mere silence of Varahamihira does not point to any plants being unknown or at any rate unfamiliar to him and his countrymen. Thus among the species mentioned in Sukraniti there are some which are indigenous to, or may be cultivated and naturalised in, all parts of India, and there is no reason why these should be peculiar to the Sukra Flora and not have been mentioned in the Ujjayini Schedule. Such cosmopolite species are (1) Famarindus indica, and (2) Phyllanthus distichas or Anona reticulata. Compared with Ujjayini Flora, the peculiarity of Sukra Flora is thus more apparent than real.

There remain now 14 species peculiar to Sukra Flora, and this in a list of 35.

- A further process of elimination is necessary to find out how far the Sukra Flora differs from the Ujjayini Flora. The seven species Santalum album, Citrus medica, Pinus longifolia, Areca catechu, Myrica sapida, Mimusops hexandra, Pongamia glabra and Juglans regia have a place in the Charaka Flora of earlier times. There is no special reason why these should not have been included, at least conventionally, in the Ujjayini list as well, like the cosmopolites we have just referred so.

The peculiar species of the Sukra Flora are thus reduced to six only :

- (1) Pyrus communis (amrita)-rare.
- (2) Morus alba or indica (tuda)
- (3) Spondias mangifera (âmrâ).
- (4) Garcinia xanthochymus (tamâla).
- (5) Diospyros melanaxylon (kuddåla).
- (6) Cocos nucifera (narikela)

Among the *Aranyaka* (wild) and *kantakina* (thorny) species mentioned by the authors of the Sukra cycle, the following have not been mentioned in the *Brihat Samhila*: (1) Tectona grandis, (2) Acacia arabica, (3) Garcinia xanthochymus or Cinnamomum tamala, (4) Holarrhena antidysenterica, (5) Cedrela toona, (6) Cedrus deodara, (7) Flacourtia sapida, (8) Carissa carandas, (9) Betula bhojapatra, (10) Strychnos nux-vomica, (11) Capparis aphylla, (12) Boswellia serrata, (13) Gmelina arborea, (14) Stephania hernandifolia, (15) Terminalia chebula, (16) Acacia tarnesiana.

Here, again, we have to note several cosmopolite species which might be included in the Ujjayini list: (1) Tectona grandis, (2) Acacia arabica, (3) Holarrhena antidysenterica, (4) Carissa carandas, (5) Acacia farnesiana, Thus we have altogether only 11 species which seem to be special to Sukranili; and this in a list pf 34.

Here, again, by comparing Charaka,¹ Ujjayini and Sukra Flora we have to eliminate six species from the 11 as special to the last. These are Cedrus deodara, Cedrela toona, Boswellia serrata, Gmelina arborea, Stephania hernandifolia and Terminalia chebula.

Thus we have only five species left as peculiar to the Sukra Flora :

- (1) Garcinia xanthochymus (Tapinchchha or tamala).
- (2) Flacourtia sapida (vikankata).
- (3) Betula bhojapatra (bhojapatra).
- (4) Strychnos nux-vomica (visamusthi)
- (5) Capparis aphylla (kariraka).

In the Varaha list we find that more than 50 per cent, of the Sukra Flora have been actually mentioned. Adding to them the plants that are very common to all parts of the country, and also those which must have been known to Varahamihira, since they have been familiar even to the Charakans of pre-Buddhistic times, we have left a very small residue that is peculiar to Sukra Flora.

It thus appears that all the Flora mentioned in Sukraniti indicate an age far removed from the days of Islamic and Portuguese influences. On the strength of botanical evidences, other things remaining the same, there can be no objection to placing the Sukraniti during the period indicated by the farthest limit Charaka, and represented by the important land-mark of the sixth century A.D., the Brihat Samhitâ

The close coincidence of Varâha and Sukra Flora leads to another important conclusion. This is about the *locale*. We have seen that the *Charaha Samhila*, being a medical work, had necessarily to be more all-India, encyclopædic and universal, so far as the vegetable kingdom was concerned. The Geography of the Charaka is therefore wide as a matter of course. But Varåhamihira, who was writing a treatise to guide the rulers of men, might be expected to be more local and address himself naturally to the needs of his own patron Bhoja, Vikramaditya? of Malwa. The chapters on agri-flori-horticulture in the Brihat Samhita constitute most probably a section dealing with the *Flora Malwensis* of the 6th cent. A. D. The absence of *Pinus longifolia*, *Cedrus deodara*, *Betula bhojapatra* and other purely Himalayan species in the Varåha list points to the local character of the Royal Botanical Garden at Ujjayini. So also the absence of *Areca catechu* and *Cocos nucifera* determines the horizon of Varåha Flora. The Varåha Flora is thus a local Ujjayini collection and represents the Upper Gangetic sub-region of Hooker's Botanical Provinces.

¹ See the list of Plants in Charaka in Vanungadhidarpana, a Bengali work in two volumes by Kavirâja Gapta of Coochbehar (1908-1909). Also chapter VII of Gondal's History of Aryan Medicinal Science (1896), and Kaviraj Avinâs Chandra Kaviratna's English Translation of Oharaka Samhitâ (1890-96), pp. 18-92.

Besides the close similarity in the lists of Flora between Varaha and Sukra, the very theory of Horti-Floriculture advocated in the treatises raises important issues regarding the time and place of Sukraniti. The two works may be compared on three topics: (1) planting of trees, (2) watering of trees, (3) nourish-. ment of trees. According to the parallel passages and various readings in Mr. Oppert's notes, it appears that the theory of Sukraniti about watering and nourishment is found in only one text—the Bengal manuscript in the possession of Dr. Râmdas Sen.

Both in matter and language the Sukraniti shows evidences of quotation, incorporation, paraphrasing and adaptation from Brihat Samhita by copyists or authors who knew geographical conditions more humid and fertile than those in Varaha's place. This has been described in a subsequent section.¹

The geographical limits common to Vedic, Charaka, Varåhamihiran and Sukra Floras comprise the Upper Gangetic plain, as they include definitely the Malwa regions. The Sukra Flora, therefore, covers this tract together with the northern regions of Himalayan flora and the south-eastern regions of the Lower Gangetic or Deltaic flora.

(D) Kâlidâsic Flora and Sukra Flora.

The Flora of Kalidasa in the 18 cantos of Raghuvamsam from the nature of the case is an epitome of the Flora Indica known to the world of letters in his days. Like the Râmâyanam and Mahâbhâratam and many of the Puranas, the Raghuvamsam is an intensely national epic, the embodiment of Hindu India, of its ideals and ambitions, and covers the Geography, Zoology, Botany, Ethnology, and History of Hindusthan from Prägjyotişa on the east to the land of the Parasikas on the west, and from the territory of the Kiratas on the North to the island of Ceylon on the south. The Raghuvamsa Flora is, therefore, no touchstone of the Sukra Flora as to its geography, though historically speaking, it supplies a good catalogue of plants, like that in Brihat Samhitâ, which were indigenous to and cultivated in India during the period between Hellenistic and Islamic influences.

But the Meghadula of Kalidasa in which the cloud has been entrusted with message from a spot in Central India (Vindhyas) to a city on Mount Kailasa in the Himalayas is more restricted in its botany. "In the first-half of the poem the Yaksa describes" * * • Mount Âmrakuta on whose peak it will rest after quenching, with showers, the forest fires; the Narmada winding at the foot of the Vindhya Hills; the town of Vidisa (Bhilsa) and the stream of the Vetravati (Betwa); the city of Ujjayini in the land of Avanti; the sacred region of Kurukşetra; the Ganges and the mountain from which she sprang, white with snow-fields; till Alaka on mount Kailasa is finally reached." As might

¹ See Sukra IV, iv, 92-93, 105-106, 107-108, 110 112, also p. 237 of Oppert's edition for various readings. Vide Brikat Samhita LV, 9, 12, 16, 17.

² Extract from Macdonell's Sanskrit Literature quoted by Mr S. C. Sarkar, M.A., of two Provincial Civil Service in the introduction to his English versical rendering of Meghadata (City Book Society, 1966). See this work for the interesting geographical and botanical notes collected from the researches of Indian and European Scholars.

be expected, the Meghaduta Flora is more extensive than Varahamihiran, as it covers the whole ground of mid-Åryavarta in the longitudinal direction and includes the latter as only one of the types represented in it. The Himalayan flora has a special place in it, as the whole Second Book of the 'Cloud-Messenger' is devoted to a description of the city on Alaka. But the eastern humid and littoral vegetation is entirely lacking in it.

The 31 species enumerated by Mr. Manamohan Chakravarti¹ as constituting the Meghaduta Flora thus comprise the Malwa (Varahamihiran) and Himalayan Flora, but exclude the Lower Gangetic. The Sukra Flora coincides in one of its aspects with this whole flora of Meghaduta, but in another respect goes beyond its limits.

The Geography of Sukra vegetation therefore includes that of Megliadutam, *i.e.*, mid-Âryavarta as a sub-region, and Eastern Âryavarta as another sub-region, but falls short of that of the Raghuvamsam which includes also the India south of the Vindhyas.

4. Concluding Remarks.

We have tentatively determined the Geography of the Sukra Flora by three independent evidences:

(1) Botanical Statistics proves it to be 'sub-tropical.'

(2) Ecology (including Meteorology and Phyto-geography) proves it to be 'Gangetic,' according to the nomenclature of Hooker.

(3) Literature or Comparative Botany proves it to be less Himalayan than Vedic and Charaka (and perhaps *Meghadula*), less encyclopædic than *Raghuvamsam*, more Himalayan than Varaha, more extensive than Varaha as including (1) Himalayan and (2) Deltaic, more extensive than Vedic and Meghadutam as including Deltaic, and probably co-extensive with Charaka.

The Vedic Flora represents Indus Plain Province (Punjab, Sindh, etc.), the Charaka, though the work of an inhabitant of the Indus Plain, represents the flora of both the Indus and the Gangetic Plains (of Hooker), as well as of the Himalayas, *i.e.*, the whole of Northern India, Varaha Flora represents Malwa and the Upper Gangetic sub-region, Raghuvamsam represents the Flora Indica according to the conditions of Poetic Art, and Meghadutam represents the Upper Gangetic sub-region together with a portion of the Himalayas.

The Sukra Flora thus represents the Upper Gangetic plain, Himalayan regions as well as the humid deltaic and littoral sections of Eastern India.

As for chronology, literary history proves the Sukra Flora to be

^{&#}x27;Quoted by Mr. S. C. Sarkar in the Notes to his English Meghaduta. Mr. Chekravarti takes Lodhra to be Bassia latifolia. Really it is Symplocus racemosa, while madhuka would be Bassia latifolia. See Griffith's Specimens of old Indian Poetry (Panini Office, 1914) '%: the whole poem in English verse.

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Islamic¹ and does not prevent it from being at least as old as Charaka. Now Pre-Islamic means the period as late as the 8th century in Sindh, 10th century in the Punjab, 11th century in Kanauj (Upper Gangetic Plain) and 12th century (1193 A.D.) at Pataliputra and Gauda (Lower Gangetic plain). But, as our geography does not take us beyond the botanical limits of the Gangetic plain, the Sukra Flora may be placed at any period between the 6th century B.C. and 12th century A.D. And if the fact of incorporation and adaptation from Varahamihira be admitted, both the Sukra Flora and the Sukra authors (at any rate, the Eastern copyists of Sukraniti) have to be placed after the 6th century A.D.

SECTION 4.

Forestry.

(a) Non-economic.

The Forests are important items in Indian social economy according to the authors of the Sukra cycle. The third and fourth stages or *āsramas* of Hindu life called Vānaprastha and Yati or Sanyāsa respectively have to be spent in the forests.^a There are elaborate rules in all Smriti Sastras regarding this retiring to, and life in, forests. The Vānaprastha stage is compulsory on all the four castes, but Yati on Brahmanas only. The function of men in the third stage is to restrain passions and activities, and in the fourth is to try to attain salvation.

Forests are the resort of people for non-Såstric motives also. Among the general rules of morality we are told that one should prefer life in a forest³

¹ It would be interesting to study the history of cultivated plants in India. Such a work should be divided into two branches: (1) Geological-giving an account of the various elemental forces that have led to the existence of Malayan, Chino-Japanese, European, African and even American species in India, and (2) Bistorical-recording the successive efforts by which Chinese, Persian and European plants have been naturalised in India. Thus we know that tobacco and potato are very modern introductions due to the Portuguese (and other European) nations. So also the Mussalman Emperors were great patrons of Economic Botany, especially of Fruitery. We read in the Ayeen Akbari [Glawdin's Translation (1783), Vol. 1., pp. 92-99]: "His Majesty is exceedingly fond of fruit; and by the great encouragement that he has given to the cultivation of fruit-trees, skilful people have come with their families from Persia and Tartary, and settled in this country." See Watt's Dictionary of the Economic Products of India and Dymock's Vegetable Materia Medica of Western India, for the history and uses of Indian plants. Cf. also, "Opium was first introduced into this country from Arabia. Its spread in India is synchronous with the advent of the Mahomedans who had adopted it as a suitable substitute for fermented liquors, which their religion discountenances. Some more drugs which happened to be introduced into India during the Mahomedan rule are :- Ala (Prunus bocariensis), Badian (Illicium anisatum), Banfasha (Viola odorata), Gaozban (Onosma bracteatum), etc."-History of Aryan Medical Science by the Thakur Sahib of Gondal, pp. 125-127. (Edition, 1896).

¹ Sukra IV, iv. 1-5.

^{&#}x27; Sakra III, 576-577.

²¹

to being dependent on others. Then the exile of Râma in a forest¹ by Dasaratha's command also points to the forest being a resort of men. There are also persons who retire to forests² after knowing of complaints against them. The law enjoins that the king should summon such people to the court to answer the charge.

The law of the realm has to provide for several classes of cases pertaining to forest. Thus if a bound-down man violates the limitations imposed upon him when crossing a forest³ or going through a difficult region, he is not guilty and should not be punished. So also in the cases of offences committed in forests⁴ *i.e.*, inaccessible regions where human evidences, *e.g.*, witnesses, &c., are not easily available, Sukracharyya ordains that divine Sādhanas or ordeals should be resorted to. Then again among the several instances of trial by peers we read that "foresters⁸ are to be tried with the help of foresters."

The existence of both religious and legal regulations points to forests being important topographical features of the country of Sukracharyya. So they are; for among the general rules we read that (1) one should not visit solitary forests,⁶ unoccupied houses, and cremation grounds even by day, and (2) one should always travel with companions, and while travelling, should not take rest on roads or in forests.⁷

That forests are familiar sights to the authors of the Sukra cycle would be evident from the characteristic analogy drawn by them in the following lines. "One should bring to bay or discipline, by the hook of knowledge, the elephant of the senses which is running to and fro in a destructive manner in the vast forest⁹ of enjoyable things."

The statesmen of the Sukra cycle, therefore, are judicious enough to devise ways and means for utilising the forests, in order to promote the prosperity and importance of their state. They have prescribed hunting excursions among the functions of the king. "He should sport with tigers, peacocks, birds and other animals of the forest,⁶ and in the course of the hunting should kill the wild ones." The ArthasAstra¹⁰ of Kautilya is more explicit on the point. We read that Chandragupta had a hunting forest exclusively for his own use. It was provided with only one entrance and had a canal running round it to ward off intrusion. Inside were planted fruit-trees, thornless trees, &c. There roamed at large not only the wilder games, but also some of the wilder ones, deprived of their natural offending weapons. *** Besides the imperial hunting forest, there was another public forest thrown open to all persons willing to hunt."

The forests are, like mines, important sources of Government revenue according to the financiers of the Sukra cycle. The Sumantra or Finance

| ' Sukra 11, 63. | • Sukra III, 60. |
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| ⁹ Sukra IV, v. 214-215. | 'Sukra III, 124. |
| • Sukra IV, v, 210-211. | * Sakra I, 193-194. |
| 4 Sukra IV, v, 509-11. | ' Sakra I, 665-668. |
| * Sukra IV, v, 44-45. | ¹⁰ Law's Studies in Hindu Polity. |

minister has to take a census 1 of the forests and study the income accruing from them.

The forests have been utilised by the Sukra statesmen for military purposes also. Among the various classes of forts we have the *vanadurga* or forest fort,^{*} which is encircled by huge thorns and clusters of trees. This type of forts is superior³ to that which is surrounded by ditches and also that which is protected by walls of bricks, mud and stones. It is, however, inferior to the desert-forts, water-forts and hill-forts.

Then an important division of the army seems to consist of people living in forests, who ordinarily are independent and do not perhaps acknowledge the suzerainty of the ruler. The king should, however, be sagacious enough to make use of them for his military defence. The section of the army composed of such recruits is called sâdyaska⁴ i.e., new or raw, as opposed to the maula, *i.e.*, standing or permanent. It is also called agulmaka i.e., one which is not officered and divided into regiments by the state, but brings its own officers and fighting apparatus. The Kiratas and people living in forests who are dependent on their own resources and strength constitute this division of the state army.

It is one of the counsels of diplomacy to try to win over these forest tribes to one's side by hook or by crook. "Peace should be made even with *andryas*,^a for otherwise they can overpower the ruler by attack;" whereas, on the contrary, if the ruler be wise enough to grant them timely concessions, reward, &c., they may stand him in good stead in times of emergency by making the enemy's progress impossible. "Just as a cluster of bamboos cannot be destroyed if surrounded by thick thoray trees, so the ruler should be like a bamboo surrounded by clusters." Such foresters as enter Government service or are otherwise useful to the king should have quarters reserved for them just outside the city limits.⁶

(b) Economic.

The economic importance of forests now remains to be considered. They are the sources of fuel, fodder, grass and timber. According to the Sukra statesmen the king should lay siege⁷ to the enemy's country from such a position as to destroy "carefully the people who help the enemy by carrying wood, water and provisions." The military manœuvres and tactics should also be dilatory and spread over a long period of time—in order that "provisions of the enemy may be cut short and food and fuel diminished." Again, "the powerful should coerce the enemy by stopping the supplies of water, provisions, fodder, grass, &c., in an unfavourable region."

Not only in warlike operations but also in the normal functions of states, Sukracharyya recognises the value of forests in the ordinary secular life of

| ' Sukra 11, 207-8, 211-212, | ⁴ Sukra IV, vii, 22-28. |
|-----------------------------|------------------------------------|
| Sukra IV, vi, 5. | * Sakra IV, vii, 482-84. |
| Sukra IV, vi, 11-12. | * Sukra I, 500-12, |
| ' Sukra IV, | rii, 570-78. |

the people. The regulations relating to the site' for the building of the capital pay due heed to this. The place is to be one which "abounds in various trees, plants and shrubs, and is rich in cattle, birds, and other animals, is endowed with good sources of water and supplies of grains, and is happily provided with resources in grasses and woods." Then, again, the collection of grasses and woods in forests has been recognised as one of the occupations and means of livelihood, and it is important enough to be reckoned in Sukra's comprehensive scheme of taxation. "The king should realise one-third, onefifth, one-seventh, one-tenth or one-twentieth from the collectors of grasses," woods &c."

Last but not least in economic importance are (1) the kantakinah^s or thorny trees which according to Sukracharyya should be planted in forests, (2) phalinah⁴ or fruit-bearing trees which should be planted very near the village, and (3) other expansive trees, shrubs,⁶ creepers, &c., which are to be carefully planted in villages, if domestic, in forests, if wild.

The classification is not at all scientific, as we have noted in a previous section. All the plants enumerated by Sukra might have been mentioned together in one list, for they all belong to the 'Flowering' or *Phanerogam* division according to the Taxonomy of modern Botanists. Economically speaking, again, this classification serves the purpose well so far as it goes, *i.e.*, as a convenient means of knowing which species may be planted in and near the homestead, and which species should be planted at a distance. But it is not the intention of the Sukra authors, nor should we interpret the classification to mean, that the *Aranyaka* or wild and forest flora are in any way less useful to man than those which have been regarded as domestic. For, from the standpoint of Utilitarian Botany, both the classes are of equal importance.

Sukracharyya has adopted only one principle of economic classification, e.g., that into domestic and wild. The result is that each of these groups may be sub-divided (a) geographically into evergreen, deciduous, or otherwise as we have seen in a previous section,⁶ and (b) economically into medicinal, industrial, etc.

* The deciduous forests yield sâl, teak, sandal, ebony, and valuable genera, e.g., Terminalia, Anogeissus, Acacia (Acacia catechu) and other trees that supply the wood olls and #arnishes largely used in the domestic life of the inhabitants of the country. * * Among trees characteristic of evergreens may be mentioned Terminalia, Cedrela toona, the wild mango, &c. Pinus longifolia flourishes at lower elevations and finally mixes with the deciduous forests of the plains. See the Chapter on Forests in the Economic Volume of the Indian Empire in Imperial Gazetteer Series, and Brihat Samhita LXX 2-4, for Hindu ideas about Timber.

¹ Sukra I, 425-428. Cf. Kámandaki Niti, iv, 50-56.

^{*} Sukra IV, ii, 237-38

^{*} Sukra IV, iv, 113-114.

⁴ Sukra IV, iv, 108.

^{*} Sukra IV, iv, 123-124.

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Uses of Plants.

"There is no plant' which has no medicinal properties," says Sukracharyya; and all the plants mentioned by the Sukra authors have one or other use in Hindu Pharmacopœia. The fact that Charaka mentions almost all of these in his maleria medica points to this.

The Sukra Flora, whether belonging to the domestic or wild class contains :

(1) Timber trees, e.g., Capparis aphylla, Garcinia xanthochymus, Calophyllum inophyllum, Bombax malabaricum, Feronia elephantum, Ægle marmelos, Zizyphus jujuba, Terminalia arjuna, Bassia latifolia, Ficus bengalensis, Ficus glomerata, Ficus religiosa, Phœnix sylvestris, Areca catechu, Dendrocalamus strictus, &c;

(2) Food plants, e.g., Capparis aphylla, Garcinia xanthochymus, Flacourtia sapida, Bombax malabaricum, Ægle marmelos, Feronia elephantum, Mangifera indica, Mimusops elengi, Bassia latifolia, Aleurites moluccana, &c.;

(3) Famine plants, e.g., Bassia latifolia, Ficus bengalensis, glomerata, geligiosa, Santalum album, Phœnix sylvestris, &c.;

(4) Fermented drinks, e.g., Bassia latifolia, Calotropis gigantea, Cocos nucifera, Phœnix sylvestris, Saccharum officinalis, &c.;

(5) Oil-yielding plants, e.g., Bassia latifolia, Semecarpus anacardium, Pongamia glabra, Butea frondosa, Terminalia bellerica, Chebula, Bassia latifolia, Cocos nucifera, Santalum, album, &c.;

(6) Fibrous plants, e.g., Butea frondosa, Calotropis gigantea, Ficus religiosa, bengalensis, Morus alba, Cocos nucifera, Phœnix sylvestris, &c.;

(7) Dyes, e.g., Garcinia xanthochymus, Zizyphus jujuba, Butea frondosa, Acacia arabica, suma, catechu, Terminalia chebula, Woodfordia floribunda, Artocarpus lakoocha, Fectona grandis, &c.;

(8) Gums and resins, e.g., Spondias mangifera, Bombax malabaricum, Feronia elephantum, Mangifera indica, Semecarpus anacardium, Butea frondosa, Terminalia bellerica, &c.;

(9) Vegetable soaps, e.g., Acacia arabica ;

(10) Vegetable poisons, e.g., Semecarpus anacardium, Strychnos nuxvomica.

(11) Vegetable antidotes to Snake-bites, e.g., Euphorbia neriifolia ;

(12) Fodder, e.g., Dendrocalamus strictus, Cicer arietinum, Ægle marmelos, Cedrela toona, Butea frondosa, Ficus bengalensis, &c. ; and

(13) Sacred Flora.

We have to notice in connexion with the economics of Forest Flora that some of the plants in Sukraniti are valuable from their uses in religious rites and ceremonies of the Hindus. One of the reasons for the inclusion of Butea frondosa, Calotropis gigantea, Ficus glomerata, religiosa, Mangifera indica, Citrus medica, Melia azadirachta, Ionesia asoka, Ægle marmelos, Michelia champaka, etc., in the Sukra Flora might be due to their importance in Hindu religious life.

1 Sukra II, 254-255.

We have not mentioned the various uses¹ which people make of the plants, trees, or shrubs that have not been included in the two lists given by Sukra but referred to incidentally. Some of those plants which have been mentioned casually, e.g., cotton, bamboo, &c., might be well-included in the two lists. The multifarious uses of the cereals, &c., whether as edibles or industrial ingredients, have also been purposely avoided here, since, though they may, like the others, be treated in connexion with forests and forest produce, they have not been mentioned by the Sukra authors separately as forming a class by themselves. All these casual references will be treated in a subsequent section in connexion with the uses made of them by Sukracharyya.

It must have been clear from the foregoing account that each of the plants mentioned by the Sukra authors serves more purpses than one, and that it is not possible to make any classification, from the standpoint of Economic Botany, without running the risk of overlapping and cross division. Incidentally also we are led to think that the country of Sukracharyya is not a purely agricultural one, but is industrial as well. In fact, among the 64 arts or kalas we have several connected with plants. These come under two heads: (1) Medical Botany and (2) Industrial Botany.

Like mineralogy, Medical Botany is an important branch of Ayurveda; and among the 10 kalâs mentioned in this science, we have, according to Sukracharyya, the following five pertaining to the vegetable kingdom alone, e.g., (1) distillation of wines and spirituous hquors from flowers, (2) extrication of thorns (3) planting, grafting and preservation of plants, (4) use of preparations from sugarcanes, (5) mixtures of metals and medicinal plants.

Wines.

References to wine and spirituous drinks are frequent in Sukraniti ;

(1) One of the 64 kalas is the distillation of wines³ and spirituous liquors from flowers, &c.

(2) Three general rules of morality have reference to liquor and enjoin temperance upon the people :

- (i) One should not visit liquor-houses at night."
- (ii) One should not sell liquor.⁶
- (iii) One should not get intoxicated with spirituous liquors."
- (3) Drinking, however, is better than other vices :
 - (i) "Even the king who is a drunkard" is good, but not he who is very angry and addicted to women. For the severe man irritates or alienates the subjects, but the other destroys the

- Sukra IV, iii, 141-47.
 - Sukra IV. iii, 141,
 Sukra III, 57-59,

• Sukra 111, 63-64.

- Sukra III, 242.
- ' Sukra IV, i, 134-25,

¹ See the Botanical Volume of the Bombuy Gasetteer, Economic Volume of the Indian Empire in Imperial Gazetteer (Chapters on Agriculture and Forests), and also Watt's Dictionary of the Economic Products of India.

castes only." It is evident that according to Sukra merality the vice which leads to civic and political deterioration or ruin is of a blacker dye than that which touches the social life only.

- (ii) "The man who drinks wine¹ is deprived of his intelligence and loses his business." But the result is not very criminal.
- (iii) Moreover, "passion and anger are greater intoxicants than wine." Greed is the cause of destruction of the life and property of subjects." Hence the king should give up these three.

(4) With regard to temperance, Sukra authors really follow the via media. For rulers as well as for people Sukracharyya advises the golden mean :³

- (i) Of the man who drinks wine excessively, intelligence disappears.
- (ii) But wine, drunk according to some measure, increases the talent, clarifies the intelligence, augments patience, and makes the mind steadfast; but otherwise it is ruinous.
- (iii) Sensuousness and anger are like wine and should be duly indulged in—the former for the maintenance of the family, the latter against enemies.
- (5) The laws of the land with regard to wines are stated below :
 - (i) Without the permission of the king, the following are not to be done by the subjects-drinking, distillation of wines.⁴
 - (ii) The Ganja house (liquor house) or tavern should be kept outside the village and the drunkards should be kept there. The king should never allow drinking⁶ of liquor in his kingdom in the day time.

Plants in relation to other kalds.

Besides Agri-flori-horti-arbori-sylvi-cultural facts and phenomena recorded in Sukrauiti, there are the industrial⁶ or manufactural aspects of Economic *i.e.* Utilitarian Botany referred to casually by the Sukra authors. The *Periplus* mentions, among other articles of trade that passed through the ports on the Arabian and Bengal coasts in the first century A. D., pepper, betel, spice, wine, wheat, sandal, aghil (kind of black aromatic wood). These uses of flora as commercial merchandise, *i.e.*, articles of trade or as raw materials for the thousand and one arts and industries in secular life demand

| ¹ Sukra IV, i, 126. | 4 Sukra I, 608-8 | |
|--------------------------------|-----------------------|--|
| " Sukra IV, i, 127-129. | * Sukra IV, iv, 89-90 | |
| | | |

'Sukra I, 229-288.

"See Baden Powell's Punjab Manufactures (1872) pp. 74-91, 203-14, Birdwood's Handbook to the Indian Section (Paris Universal Exhibition, 1878) pp. 77-79, 88-84, Maffey's Monograph on Wood Carving (U. P. 1908) pp. 10-14, Wales' Monograph on Wood Carving (Bombay, 1992) pp. 2-3, also the historical works on Indian art quoted several times. our attention here. The mention of or allusion to these industrial facts in Sukraniti is to be noticed mainly in the sections dealing with the 64 kalås and with the list of artisans to be maintained by the state, but should also be soughthere and there and everywhere in the treatise. References to construction of bridges, boats, cars, chariots, war-implements, arms and weapons, wooden images, temples, palaces, forts, ploughs, &c., as well as other processes and products that point to the utilisation of timber and the art of the carpenter, are instances in point, and bespeak the existence of timber-merchants as well as various grades of wood-carvers and carpenters connected with domestic, religious, architectural, military and agricultural arts.

We have also noted the Ayurvedic preparations from the vegetable drugs of the country mentioned in Sukranîti, as well as the trade in medicinal herbs, suggested by various passages in it. We have already noted the mention of honey as a floral produce.

Other kalâs or industries connected with plants are (1) cleansing, polishing, dyeing, &c., of wooden vessels,¹ (2) preparation of boats, chariots and conveyances^a (3) preparation of threads³ and ropes, (4) weaving of fabrics by various threads,^a (5) extraction of oil from seeds,^b (6) climbing of trees,^e (7) preparation of vessels with bamboo, straws,⁷ &c., and (8) making and preservation of betels.^e

(c) Administration.

Sukraniti thus bears testimony to the varied importance of forests in the economy of social life. The Sukra statesmen, therefore, have organised a special department of the state to look after the interests involved in its vegetable resources.

The department is broadly divisible into two sections: (1) Parks, public grounds or pleasure-gardens and (2) Forests, strictly so called.

The Sukra statesmen advise the king to give away lands for the gods, for parks and public grounds,⁹ and for dwelling-houses to the peasants," but for no other purpose. Among the general laws of the land we have, "you must never obstruct the tanks, wells, parks,¹⁰ boundaries, &c." The parks are the

' Sukra IV, iii, 167-168.

[•] Sukra IV, iii, 173. The uses and classes of timber and all such questions relating to the "strength of materials" have been detailed in Yukti-kalpataru. This work has been utilised by Råjendrålal in his description of Hindu Furniture and Prof. Radbakumud in the History of Indian Shipping. cf. also Brihat Samhitâ.

^s Sukra IV, iii, 174.

⁴ Sukra IV, iii, 175. See some of the traditions connected with the origin of the weaving art in pp. 2-3 of Silberrad's Monograph on Cotton Fabrics (&c. p. 1898), the chapter on Fibrous Manufactures in Baden Powell's Punjab Manufactures, pp. 74-91, and Birdwood's Paris Universal Exhibition 1878, pp. 88-110. cf. also Thurston's Monograph on Cotton Fabric Industry (Madras, 1897) and Twigg's Carpet making in the Bombay Presidency (1907).

* Sukra IV, iii, 187.

" Sukra IV, iii, 188.

' Sukra IV, iii, 190.

Sukra IV, iii, 198.
 Sukra II, 423-424.
 Sukra I, 601-602.

resorts of people as well the king for recreation; and Sukracharyya advises the ruler to cultivate social habits in such places. "In parks¹ and places of entertainment, the king should carefully indulge in enjoyments with the people, women, actors, musicians, poets, and magicians." The encyclopædic scheme of general culture devised by the Sukra statesmen is thus adapted to make of the king a perfect gentleman according to the ideas of the time, and quite up to date in notions, tastes, and sentiments.

Parks do not seem to have been insignificant features of social life in Sukra's days. They are important enough to have given rise to special classes of skilled artisans. So the advice is that among goldsmiths, gunners, miners, &c., who deserve the patronage and 'protection' of the state should be included men who "construct parks," artificial forests and pleasure-gardens." Nor is this all; they are also considerable enough to have been regarded as important items of state 'consumption.' The expenditure on parks is also definitely mentioned as one that belongs to the upabhogya" class.

The second section of the Forest Department has jurisdiction over forests properly so called. The parks[•] are meant for health, recreation, enjoyment, &c., and constitute the spending department pure and simple; whereas the forests, as we have seen in the previous -ection, are important sources of national wealth as well as Government revenue. Both these sections, however, are under the management and control of an officer, called the *ârâmâdhipati*[§] ör the Superintendent of Parks and Forests. The qualifications of the Forestofficer, according to Sukrâchâryya, should be a sound knowledge of agri-flotihorti-culture. He is to "know the causes of the growth[®] and development of flowers and fruits, the methods of planting and cuing trees by the administration of proper soil and water at the suitable time, and the various uses of plants as medicinal drugs."

The Forest-officer is called kupyadhyakaa in the Arthasåstra of Chanakya.' He (1) is in charge of the imperial hunting forest, (2) public hunting forest, and (3) has to perform a duty in connexion with the live-stock, viz., the capture, when needed, of birds and beasts that live in the forests under his jurisdiction.

*See the description of Parks and Forests in Kámanduki, XIV, 27-42. Kámandaka has devised the scheme of a regulated and restrained indulgence in *Mrigaya* or hunting and sportsmanship for the king, by purposely allowing the construction of such parks and forests. According to him, these are the necessary institutions of a state, and hence inevitable charges upon the public revenues, for otherwise the king may be tempted to undertake "wild goose chase" and indulge in excessive hunting which would thus degenerate into a vicious vyasana.

* Sukra II, 240.

* Sukra II, 817-819.

* See in the Modern Review for August, 1911, the paper on the Department of Livestock in Chandragupta's Administration by Narendranath Law.

¹ Sukra I, 061-62.

³ Sukra II, 83.

^a Sukra II, 689-91.

The great assembly (Mahasabha) of the village, the unit of administration in the Chola Empire, was divided into several committees—one of which was elected for the supervision of gardens.

The following extract from Mr. Aiyangar's Ancient India' gives an idea of the importance of flower-gardens in mediæval Chola life (800-1100 A.D.): "The third published inscription records that a certain Perran Adittan of the Chola country purchased two pieces of land, and made over both pieces to the villagers for maintaining a flower-garden. * * * Having received in full the purchasemoney and the revenue of the land and having exempted the flower-garden (and the land assigned) for the maintenance of the garden from taxes for as long as the moon and the sun exist, we the assembly engraved this on stone."

We are not sure if, besides having a knowledge of the matters connected with the *direct* utility of forests, the Superintendent of Parks and Forests in Sukraniti and Arthasåstra is to have also a knowledge of their *indirect* utility, *e.g.*, "that through the influence which they exercise upon climate, the regulation of moisture, the stability of the soil, the healthiness and beauty of the country and allied subjects." That this topic, however, was not wholly unstudied by the Hindus of yore may be demonstrated by references to Chapters XXIX, LIV, and LV of Varahamihira's Brihat Samhitā, which, "although an astrological work, contains," according to Dr. Kern, "important astronomical data, and its value for geography, architecture, sculpture, etc., is unequalled by any Sanskrit work as yet published."

In the following section we have quoted Varahamihira's ideas about the influence of plants on (1) other plants and (2) climate. Varahamihira's theory of Sylviculture guarantees the forecast of rain, storm, drought, health, famine, destructive fire, disease, &c., from the growth or otherwise of certain plants.

The following extract from *Encyclopædia Britannica* supplies interesting information regarding Forestry :"

" In early times there was practically no forest-management. As long as the forests occupied considerable areas, their produce was looked upon as the free gift of nature, like air and water; men took it, used it, and even destroyed it without let or hindrance. With the gradual increase of population and the consequent reduction of the forest area, proprietary ideas developed; people claimed the ownership of certain forests and proceeded to protect them against outsiders. Subsequently the law of the country was called in to help in protection, leading to the promulgation of special forest law. By degrees it was found that mere protection was not sufficient and that steps must be taken to enforce a more judicious treatment. The teaching of natural science and political economy was brought to bear upon the subject, so that now forestry has become a special science."

The history of forest administration in British India is being given from the same source : " With the advent of British rule forest destruction became

¹ Pp. 160, 164, 169.

Article on Forests and Forestry in Encyclopædia Britannica, (1th Edition.

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more rapid than ever. ** * Then railways came and with their extension the forests suffered anew, partly on account of the increased demand for timber and firewood, and partly on account of the fresh impetus given to cultivation along their routes. Ultimately, when failure to meet the requirements of public works was brought to notice it was recognised that a grievous mistake had been made in allowing the forests to be recklessly destroyed. Already in the early part of the 19th century sporadic efforts were made to protect the forests in various parts of the country; and these continued intermittently; but the first organised steps were taken about the year 1855. * * In 1864 an organised state department was established."

The importance of forests in Indian life is thus described by Mr. S. Eardley-Wilmot, Inspector-General of Forests in the Economic Volume of the *Indian Empire*¹ in the Imperial Gazetteer Series: "The grazing which they annually afford to countless herds assumes a special value in years of drought, when it renders material assistance in saving from starvation the cattle upon which the agriculture of the country depends. They afford the villagers who live in their vicinity a ready supply of material for house-building and thatching, of fuel, and of minor forest products, which add substantially to the comforts of their life. And the use of forest leaves as manure for the cultivator's fields has already assumed large dimensions."

About the Hindu idea regarding Protection of forests and trees we have the following from the Siddhanta Dipika for December, 1906:--

"Dewan Bahadur R. Raghunath Rao writes in the Madras Standard as follows: -I am afraid this is not generally known to the European public what the feelings and opinions of the Hindus are regarding forests and trees. Their religion tells them that trees have souls like men; that cutting down a living tree is as bad as killing a living man; that their twigs, even branches, leaves, when absolutely required, should be removed without any harm to the trees; that only dried trees should be cut down for fuel; that forests should not be destroyed because, in addition to other reasons, they are the residence of the third and fourth \hat{A} sramas of the Dwijas; that trees also are the tabernacles of God, and that to plant a tree is a virtuous act, and so on.

"The Hindus do not and cannot therefore advocate the indiscriminate destruction of forests. There is a belief that one is allowed to live in a more pleasant world than this, so long as the trees planted by him here exist. Any indiscriminate destruction of trees is very abhorrent to a true Hindu."

SECTION 5.

Horti-Flori-Arbori-culture.

The gardener and weaver of garlands are two of the familiar members of the community described by the authors of the Sukra cycle. It is their arts that supply the analogy for a judicious 'exploitation.' Sukra says : "The gardener

¹ See the chapter on Forests for an account of their economic and financial importance in modern India.

collects flowers and fruits,¹ after having duly nourished the trees with care. The collector of taxes is to be like him." Again, "the best king is he who, by following the practice of the weaver of garlands,^a protects his subjects, makes the enemies tributaries and increases the treasure by their wealth." Further, "the king should receive rent from the peasant in such a way that he be not destroyed. It is to be realised in the fashion of the weaver of garlands³ and not of the merchant who deals in fuel and firewood."

We have two sets of officers in *Sukraniti* for discharging two kinds of functions in connexion with vegetables:

(1) The superintendent of parks and forests studies the growth and development of plants in *gardens*, parks, forests, &c., and is well up in the *kalå* that relates to these, and

(2) The superintendent of grains who discovers the good ones by discriminating them from the worthless.

(a) Sukrâchâryya on Practical Gardening.

The following are the rules about the planting of trees⁴ in gardens or forests to be observed by the superintendent :

(1) The good plants are to be placed at a distance of 20 cubits from one another.

(a) The middling plants are to be placed at a distance of 15 cubits from 1 one another.

(3) There should be a space of 10 cubits between two ordinary plants.

(4) The space should be 5 cubits between two youngest plants.

The following rules relate to the watering of plants :5

(1) In summer the trees are to be watered twice in the morning and in the evening.

(2) In winter they are to be watered every alternate day (or at mid-day).

(3) In spring they should be watered in the fifth part of the day, in the afternoon.

(4) In the rainy season the plants do not require any watering.

The following rules are to be observed with regard to the nourishment of plants :

(1) Stools of goats, sheep and cows,⁶ water as well as meat should be generally used to promote the healthy growth of plants.

(2) In abnormal cases the following recipe is to be tried: "If trees have their fruits destroyed, the pouring of cold water after being cooked together

¹ Sukra II, 845-46.

² Sukra IV, ii, 35-38.

^{*} Sukra IV, ii, 222-28

^{&#}x27; Sukra IV, iv, 91-93. Cf. Brihat Samhitå, LV, 9.

^{*} Sukra IV, iv, 105-106. Cf. Brihat Samhitâ, LV, 15.

[•] Sukra IV, iv, 94.

with Kulutha (donchos biflorus), masa (phaseolus radiatus), mudga, (phaseolus mungo), yava (hordeum vulgare), and tila (sesamum indicum) would lead to the growth of flowers and fruits."¹

(3) A third process consists in the application of water with which fishes are washed and cleansed.^a

(4) The fourth recipe is given below: The powder of the dungs of goats and sheep, the powder of hordeum vulgare, sesamum indicum, beef³ as well as water should be kept together undistuibed for seven nights. The application of this water conduces very much to the growth of all trees in flowers and fruits.

As for the sites where particular plants are to be placed the following are the rules:

(1) Those trees which bear good flowers should be planted very near the village.⁴

(2) A fair garden should be laid out to the left of the dwelling-house."

(3) Those trees which bear thorns, e.g., acacia catechu are known as \hat{A} ranyaka and should be planted in forests⁶.

(4) Expansive trees, shrubs and creepers are to be carefully planted in villages, if domestic, in forests, if wild.'

The knowledge of grafting^{*} is certainly one of the qualifications of the gardener, as it is known to be one of the sixty-four kalas.

(b) Varâhamihıra on Ecology.

A few notions of the Hindus regarding the connexion between plant life and its environment (both botanical and meteorological) are given below from *Brihat Samhitá*,^{*} and are to be taken for what they are worth:

(1) Judging from the growth of the fruits and flowers of trees and plants we may determine beforehand what articles can be had cheap and in abundance and what crops will thrive.

¹ Sukra IV, iv, 107-108. Cf. Brihat Samhitá LV, 16. In the chapter on Empirical Recipes from Varáhamihira, relating to Chemical Technology, Dr. Seal remarks: "It will be seen that these elaborate recipes are empirical contrivances for supplying the requisite nitrogen compounds, phosphates and bacteria, these being potentially contained in the mixtures and infusions prescribed." Vide Ray's Hindu Chemistry, Vol. 11. pp. **185** 90.

^s Sukra IV, iv, 109.

³ Sukra IV, iv, 110-112. Cf. Brihat Samhita LV, 17-18.

⁴ Sukra IV, iv, 103. The plants have been enumerated in a previous section.

Sukra IV, iv, 104. cf. also Bacon's Essays.

* Sukra IV, iv, 118-114.

⁷ Sukra IV, iv, 123-124.

* Sukra IV, iii, 144.

* See chapter XXIX. 1, 14. cf. also " If mango tree should thrive well, there will be prosperity in the land; if bhallåta should thrive, there will be fear; if peelu (Dillenia spaciosa), there will be health; if khadira and śamî, there will be famine; if arjuna, there will be good rain. If kapittha should bear blossoms, there will be storm; if nichula (Barringtonia acutangula) should bear blossoms, there will be drought; and if kutaja, there will be disease." (2) There will be good rain in those countries where trees, shrubs and creepers grow luxuriantly with glossy leaves uninjured by worms, but if the leaves should be otherwise there will be little rain.

These two principles sum up what in Varahamihira's time (6th century A.D.) constituted the results of scientific observation regarding plants (1) in relation to other plants and (2) in relation to the atmospherical conditions. The first has in modern times developed into the science of ecology, and the second into that aspect of the science of forestry or sylviculture which deals with the influence of vegetation on temperature, humidity and climate.

The following interesting extracts from Brihat Samhilâ would give an idea of Varahamihira's economic ecology:

(1) If the sâla tree should bear fruits and flowers, karama (white rice) will grow in abundance; if the red asoka should bear fruits and flowers, red paddy will grow; if the ksirika should bear fruits and flowers, white paddy will grow; and if the black asoka should bear fruits and flowers, black rice will grow.

(2) The growth of the nyagrodha (the banyan tree) indicates the growth of barley; the growth of tinduka indicates the growth of the sastyaka rice; and the growth of the aswattha indicates the growth of all crops.

(3) The growth of madhuka indicates the growth of wheat, and the growth of saptaparna indicates the growth of the barley, etc., etc., etc.¹

It would be better to describe this Hindu ecology of the early Christian era as Astrological Botany. It may be surmised that the forester, superintendent of parks and the gardener of those days were acquainted with all these notions about the principles of plant life. These look very much like the sayings of the celebrated Khanâ—the most popular agricultural lore of Bengal.

Likewise, the gardener of old must have been familiar with the following views of the scientist of the court of Bhoja Vikramåditya :

(1) The sides of rivers' and lakes and other water-banks will not be pleasant and agreeable, if devoid of shady trees.

(2) Soft soil is congenial to the growth of all trees. Such a soil should be selected for the garden, and the sesamum plant should first be grown in it.

(3) Trees that grow without branches shall be grown in the Sisira season, and in the Hemanta shall be grown trees that grow with branches; in the winter season shall be grown trees possessing good trunks.

(c) Sukra vs. Varâha.

We may compare and contrast the horticutural ideas of Sukracharyya with what we may look upon as the practice in the Royal Garden at Ujjayini in the 6th century. We have the following lines in *Brihat Samhita*: (1) "In

¹ See Iyer's Brihat Sumhità pp. 188-140. The accounts of plants that by their growth or otherwise indicate rise or fall in the supply of metals, gems, livestock, do, and prosperity or adversity of certain classes of men, e.g., princes, ministers, dc., should also be noted. of. also Sen's Bengali Literature for the sayings of Khanâ.

[·] Brihat Samhita LV., 1, 2-6.

the dry season¹ the trees shall be watered both in the morning and evening; in the cold season they shall be watered every alternate day (at mid-day?); and in the rainy season whenever the ground is found dry."

The fact that even in the rainy season plants require watering indicates the great absence of humidity in the soil of Malwa for which Brihat Samhitâ was probably written; and the fact that the Sukra authors advise no watering during the rainy season points to an opposite state of things—copious rainfall, natural moisture in the soil, &c., known to them. We have also to note that Varaha mentions only three seasons, whereas in Sukra we have six, though with regard to watering of plants only four of them are mentioned. It may be inferred from all this that Sukra's rules are the results of observation of a more humid than the Varaha flora. This would very well suit the topographical conditions of Eastern India.²

(2) An interval of 20 cubits³ between trees is the best; one of 16 is passable; and one of 12 is injurious. The trees that are planted very near each other get their branches interwoven as well as their roots, and such trees get choked and cannot grow well.

But according to Sukracharyya intervals of 15, 10 and even 5 are allowed. Here again we may consider the difference to be due to two characteristics of soil,—one being more fertile or humid is more capable of bearing vegetation per foot than the other which is drier and more barren. Sukra's rules therefore are adapted to the topographical features of luxuriant flora, while Varaha's to those of arid vegetation.

The horti-flori-arbori-cultural theories advocated by the authors of the Sukra cycle are thus "relative " to, and indicative of, the botanical conditions of a more humid and productive region than Malwa. This is Eastern India.

The Botanical evidences thus all point to the *locale* of Sukra flora and Sukra authors being somewhere in Eastern India. Comparing the texts of Sukraniti and Brihat Samhita as regards the watering and planting of trees we may also presume, unless there be other evidences, that :

(1) the difference in treatment is the conscious work of Eastern authors or copyists, and

(2) the authors or copyists of Sukraniti, in quoting passages from Brihat Samhita or from floating literature, adapted them to the local conditions of the Eastern kingdom.

Brihat Samhitâ LV, 9.

² This would be evident from a comparison of the Sanskrit texts also. Line 105 of IV, iv, of Sukra is exactly the same as the first half of the Sloka 9 of LV of Brihat Samhitå. It is only the second half that differs from each other. It has to be noted again that the lines in Sukraniti (104-112) are to be found in only one of the six texts on which Mr. Oppert edited his book; and that is the text in the possession of Dr. Rém Dása Sen of Berhampur (Bengal). The Eastern copyist or scholar in transferring the passage from Brihat Samhitå to Sukraniti adapted the idea to the geographical conditions of his own country.

Brihat Samhita LV, 12-18.

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(d) Hindu Phyto-pathology.

The horticulturist, as we have seen, must know the principles of phytopathology and be competent enough to diagnose the diseases¹ of plants and find out the enemies of their proper growth. It is also one of his functions to treat the plants with proper medicines and help forward their natural growth and development. We have already noticed the four recipes of Sukracharyya. To these we may add the following four from *Brihat Samhitâ*; two of which are similar to those we know :

(1) To cure the tree of these diseases, first scrape off or otherwise remove the parts dead from the tree with a knife; rub over the parts with a mixture of vidanga (Erycibe paniculata', ghee and mire, and pour at the roots water mixed with milk.²

(2) "If the fruits are seen to die out, then heat a mixture of horse gram, black gram and mudga, sesamum seeds and barley; after the mixture has fully cooled pour it at the roots. Then the trees will yield increase of flowers and fruits." This is exactly one of the recipes of Sukra.³ It is to be noted, however, that this is to be found in only one of the texts on which Mr. Oppert based his publication of Sukraniti. This text is that in the possession of Dr. Râmdâs Sen of Bengal.

(3) "Get two âdhakas of the excrement of the goat and the ram, an âdhaka of sesamum seed, half an âdhaka of saklu, an âdhaka of water, and a

¹ According to Varáha "cold winds and hot sun produce diseases in trees, and the trees turn white and do not put forth new leaves; the branches become dry, and the juïco oozes out." LV, 14.

"The existence of blights and mildews of cereals had been observed and recorded in very ancient times, as witness the Bible, where half a dozen references to such scourges occur in the Old Testament alone. The epidemic nature of wheat rust was known to Aristotle about 350 B.C., and the Greeks and Romans knew these epidemics well, their philosophers having shrowd speculations as to causes, while the people had characteristic superstitions regarding them. Pliny knew that flies emerge from galls. The few records during the middle ages are borne out by what is known of famines and pestilences. Cf. Shakespeare's King Lear, Act 111, Sc. iv." - Encyclopædia Britannica, 11th Edition, Vol.XXI, (Pathology of Plants).

The following letter to Major B. D. Basu from late Surgeon-General George Bidie, C.I.E. testifies to the practical knowledge of Indian cultivators in phyto-pathology even in modern times: "The achievement on which I place perhaps most value was the discovery of a remedy for the coffee borcs, which threatened to ruin the coffee industry. The remedy was a simple one, viz., cultivating the coffee under the shade of other trees which protects it from the insect. The native practice in their gardens led me on to this discovery in practical Zoology." (19th July, 1894. Porthshire N.B.)

¹ Brihat Samhita LV, 15.

 Ibid LV, 16. Cf. Eukra IV, iv, 107 108. The verse is the same in both treatises except in one or two unimportant words. We may believe rationally that the Bengal Pandit of old interpolated this verse from Brihat Samhitá and made it a part of his MSS. of Sukranîti. tula (100 palas) of cow's flesh. Form a mixture of these, keep it untouched for seven days, and if, at the end of the time, spreading creepers, plants and trees be watered with the mixture, flowers and fruits will grow in abundance."

This, again, is another of Sukra's methods.¹ The languages of the verse in Sukra and Varaha differ; but, except for the measurements (adhaka, &c.) given in the latter, the two are substantially the same.

(4) Keep the seeds soaked in milk for 10 days; then rubbing ghee over the hands the seed shall be taken up in the hands and passed from hand to hand till it is covered with ghee. It shall then be rubbed over several times with cowdung and exposed to the smoke of the flesh of the hog and the deer. It shall then be mixed with the serum or marrow of the flesh of the fish and the pig, and when dry it shall be sown in a well-prepared soil and watered with a mixture of milk and water. When it grows, it will grow with flowers,

The similarity between Sukraniti and Brihat Samhita in the two recipes cannot be interpreted to indicate the priority of the one or the other until other evidences are available. If the Doctrine of Navagraha and Navaratna utilised in Sukraniti be the work of the same age that is responsible for the agriflori-horti-arbori-cultural section, Sukraniti is certainly subsequent to Brihat Samhita, and the Sukra authors must have quoted and paraphrased the two recipes from Varaha or drawn upon the floating literature on the subject.

(e) The Luther Burbank of Hindu India.

Brihat Samhitå is further interesting to us as giving the methods of producing some botanical wonders. Thus we read (1) how the tamarind and other trees can by proper treatment be made to grow up as creepers, (2) how a plant can be made to grow up full-fledged, like Minerva born cap-à-pie, with branches and fruits, (3) how a plant can grow and bear fruits in a day; and so on.

Mr. Chidambram lyer, translator of Brihat Samhitâ, adds to the section on Gardening interesting notes derived from a work known as Brihat Sårangadhara. This work describes the horticultural processes by which (1) scentless flowers may become fragrant, (2) the cotton-plant will yield cotton throughout the year bright and red as fire, (3) trees will yield flowers at unusual seasons, (4) fruits will grow without bones, (5) fruits will ever remain unripe, (6) fruits will stick to the tree for a very long time; and so on.

The following miracles in horticulture are guaranteed by Brihat Sarangadhara.¹

(1) If the root of the plantain tree be drenched with the blood or serum . (of flesh) of the hog or with the decoction of the fruit of the ankola (alangium hexapetalum), it will bear pomegranate fruits.

¹ Here again, it is only in the Bengal MSS, that we have this recipe. (cf. Sakra IV, iv, 110-112). It is to be easily surmised that the Eastern copyist or scholar incorporated the passage of Varahamihirs with his text of Sukraniti in order to make it more important as a manual of gardening, do. In doing this he, however, does not quote in toto, but paraphrases the idea in his own language.

^{&#}x27; Iyer's Brihat Samhita, Part II, pp. 59-06.

(z) If the plantain tree be watered with a liquid mixture consisting of the flesh, serum, and blood of men and the powdered tooth of elephant and water, the tree will yield mango fruits.

Mr. Edward Lee Greene' bears out such ideas of transmutation existing in the western world:

"In this 20th century of our era there are farmers in the world, and not unintelligent, who believe that to some seed of wheat or barley after it has been sown in the field something may happen by which it comes to sprout and grow up into a plant of what they call chess or cheat; a plant known to botanists as *Bromus secalinus.* * * The seemingly indicative facts upon which this transmutation theory appears as if it might have established itself in the minds of pre-historic grain-growers were several. * * Theophrastus does not formally and didactically discuss this question, though he makes a number of references to this changing of one plant into another as something universally believed in his day. * * It was the metamorphosis attending the development of the individual reptile and the insect which helped to elevate to the dignity of a quasi-rational behef the superstition of the changeability of wheat into lolium."

If the complete transformation of orders and genera be absurd, that of species is not so and has been verified by experiments. With the horticultural miracles guaranteed by Varåhamihira and Brihat Sårangadhara of old we are tempted to compare the epoch-making new creations in plant-life by Burbank, the American plant-breeder of modern times, "which have added to the wealth of nations and enriched the dietary of the race, and have made the world more beautiful." The wonderful achievements of this great and unique genius include among other creations the following: the improved thornless and spineless edible cactus, food for man and beast, to be the reclamation of the deserts of the world; the primus berry, a union of rasp-berry and black-berry, the first recorded instance of the creation of a new species; a tree which grows more rapidly than any other tree ever known in the temperate zones of the world; a dahlia with its disagreeable odour driven out and in its place the odour of the magnolia blossom substituted; a chestnut tree which bears nuts in eighteen months from time of seed-planting.

Regarding the creation of new species Mr. Harwood in his authoritative account of the life and work of Luther Burbank writes: "Should a dweller upon some other planet where some other sun kisses its earth into life come down through space bearing a fruit as yet untasted by the world-men, it would not be more distinctive or more delicious to the taste, than the fruit which Mr. Burbank picked one summer day from a *tree which he had made from three* other trees. For the fruit which he picked was unlike any other fruit which 'had grown on the earth before—it was absolutely new, he had accomplished

¹ Landmarks of Botanical History (Smithsonian Institution, U. S. A. 1906), pp. 185-140.

^{*} See New Oreations in Plant-life by Harwood (Macmillan & Co., 1905).

that which men had said was impossible. So it has been said on other occasions, - such and such things cannot be done. Mr. Burbank says wait; let us see about it.

"He took a wild American plum, a Japanese plum, and an apricot. He bred these three together and made a third, the plumest, different in texture, colour and taste from any other fruit. * * * Indeed there are now opened in many lines of plant-life, by this demonstration of the feasibility of creating new species, possibilities whose scope is limitless."

It seems well nigh impossible to-day to venture describing with any precision the exact character of the new forms and improvements in plantlife that testified to the skill of the practical agriculturists and farmers of ancient India in breeding and selection.

(f) Bolany in Fine Arts.

Sukra authors have not supplied us with much information about these and other branches of Economic Botany, as Raja Bhoja, the author of Yuklikalpalaru does. Nor do they refer to the treatment of vegetable motives in art.

Like the metals and animals of the country, the indigenous plants also have left their permanent impress upon Hindu art. The treatment of vegetables in sculpture has been thus remarked upon by Dr. Rajendralal in *Indo-Aryans*: "The lotus, as may be expected from the circumstance of its being the most gorgeous and handsome flower in India, is by far the greatest favourite, and in Orissa, as elsewhere, occurs everywhere and in various formsin bud, in a half-open state, and in full-blown flowers. In some specimens the attempt to delineate nature is very nearly successful, but a conventional form is what is generally adopted. * * The attempt of the Orissan artist to represent vegetable forms will be readily acknowledged to have been much more successful than that of Egyptian and Assyrian sculptors. * * * The Uriya artists depended very largely on the beauty of their vegetable forms for the success of their works, and introduced them as primary, and not as accessory, ornaments in their architecture much more extensively than any other nation of antiquity."

Among the simplest objects of nature pressed into the artists' service in the Ajanta Paintings of the 5th-7th cent. A.D., Mr. Griffiths¹ mentions the "large pink lotus, full-bloom, half-bloom, and in bud, as well as the smaller red and white; the mango (*Mangifera indica*), custard-apple (*Anona squamosa*), a round fruit which may be called the bel (Marmelos ægle) or the lime (Citrus medica); another that looks like the brinjal (Solanum melongina).

The following remarks regarding vegetable life in Hindu art are taken from Vincent Smith's *History of Fine Art in India and Ceylon*: " The use of a long undulating stem, hand, garland or roll to break up a long frieze into sections was familiar to Indian sculptors from early days. As seen on Bharbut

¹ Quoted by Smith in Hist. of Fine Art, p. 280.

² Ibid, pp. . 384, 386, 888.

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coping, the device used is a lotus stem with jack fruits attached. * * * The introduction of the vine into Indian bas-reliefs used to be considered as in itself evidence of copying from Hellenistic models. But that view is not tenable. Sir George Watt believes that the plant is indigenous on the Lower Himalayan ranges, and is even inclined to think that its cultivation may have been diffused into Europe from that region. * * * The Indian aptitude for artistic representation of plant-life certainly was not learned from the Greeks, who could not teach the lesson. Sir George Watt points out to me that the pinnate foliage motives are distinctively Indian."

Mr. Grunwedel¹ in his Buddhist Art in India bears the following testimony to the successful treatment of foliage by the Hindu craftsmen: "The Indian plant-world, notwithstanding simple and sometimes even rough modelling, is reproduced with astonishing fidelity to nature. *** The Hindu sculptor does not care for purely geometrical designs, and so we find frequently creepers with aquatic birds, &c., which, on a smaller scale, fill in the spaces, and are rich and animated with fine observation of nature. *** Birds flit about among the flowers; and the plant itself grows from the jaws of a sea-monster. *** In the main, it may be said that these plants, represented in simple lines, with the native animals that animate them—both of which have received purely native modelling—mostly surpass what the celebrated Greek art was able to command: They rest upon a faithful observation of nature."

SECTION 6.

Agriculture.

(a) Agricultural Occupation, Population, and Tenure

The means of livelihood^a enumerated in *Sukraniti* are : (1) learned professions—art of teaching, etc. (2) service, (3) heroism (soldier's art), (4) agriculture, (5) usury, (6) commerce—shop-keeping, (7) industries and arts, (8) begging.

Agriculture is one of the four subjects dealt with in the science of Varta. "In Varta are treated (1) interest, (2) agriculture, (3) commerce, and (4) preservation of cows. The man who is well up in Varta need not be anxious for earnings." About the occupation of agriculture Sukracharyya's general idea is (1) that it is superior¹⁰ to that of the Vaisyas, *i.e.*, commerce, and menial service of the Sûdras; and (2) that it is too important to be left to a proxy.⁴

Even Brahmans⁶ can take to agriculture according to Manu, says Sukracharyya.

Among the 64 kalás we have only one connected with agriculture, vis, that of drawing the plough.⁶ It would thus appear that agriculture was not

¹ English Edition (Bernard Quaritch, London, 1901), pp. 19-20.

³Sukra I, 811-12. The two sciences Varta and Danduniti together constitute Arthaeastra (a variety of Nitisstra).

^{&#}x27; Sukra 111, 552-54.

⁴ Sakra III, 588-84.

[•] Sukra III, 864-67.

^{&#}x27; Sukra IV, 111, 87.

probably regarded as a hald. Besides, it may be remarked that the country of Sukracharyya was not purely an agricultural one, but industrial as well.

In agriculture-as in shop, keeping and other occupations, women are to be assistants of males.

Agriculture is also one of the occupations which should be patronised' by the state.

The equitable law of Sukra statesmen exempts agriculturists in the harvest seasons from liability to give evidence." Another law with regard to the peasant class is that, like the artists, ascetics, &c., the cultivators should have their disputes decided "according to the usages of their guild," because "it is impossible to detect them through others' help." The truth and evidences are to be found out with the help of persons born of (i.e., connected with) them. Sukra legislators have mentioned a third law relating to the peasants. This is about joint-stock enterprise which "applies equally to commerce and agriculture."⁴ The law is stated below :

"Those who deal in gold, grains and liquids (collectively) will have earnings according to the amount of their share, greater, equal or less." We noticed this law in connexion with metals in a previous section.

It is to be noted that all these secular laws apply to the Mlechchhas^a also, though they may follow "other masters" in religious beliefs and practices.

About agricultural tools and implements Sukratiti is not a good source of information. We have noticed the plough already. About agricultural livestock we have the following rule :⁷

| should | have | 10 | cows to | their | plough |
|--------|-----------------------|---|---|---|---|
| " | " | 12 | ** | " | ** |
| " | ** | 8 | ** | ,, | ,, |
| ** | ** | 4 | 31 | " | ,, |
| | " | 2 | " | " | " |
| | should " " " | should have """""""""""""""""""""""""""""""""""" | should have 16 ,, ,, 12 ,, ,, 8 ,, ,, 4 ,, ,, 2 | should have 16 cows to , , , 12 , , , , 8 , , , 4 , , , 2 , | should have 16 cows to their " " " " " " 12 " " " " 8 " " " " 4 " " " " 2 " " |

There are various kinds of soils with varying degrees of fertility and access to market. The Sukra financiers recognise the consequent variation in Agricultural Returns and have apportioned the Land Revenue in an equitable manner. The following land-laws are what we get about rents, revenues, tenures, &c., affecting the agricultural population of the country :

(1) . The king should receive rent[®] from the peasant in such a way that he be not destroyed. It is to be realised in the fashion of the weaver of the garland who, in plucking flowers from plants, takes care that the stock be not exhausted, and not of the charcoal or fuel merchant who destroys the wood altogether.

| 1 Bakra IV, iv, 54. | ' Sukra IV, v, 618. |
|-------------------------|---|
| " Sukra IV, iv, 85-87. | • Sukra IV, v, 614-17. |
| • Sukra IV, v, 206-207. | ' -ukra IV, v, 585-87 ; IV, v, 74-77. |
| * Sukra IV. v. 35-87. | * Sukra IV, iii, 88-89. |
| | T 100 10 - have the forestame attend many |

* Sukra IV, ii, 222-23. See also Sukra I, 416-19, where the systems of land-measurement according to Manu and Prajapati are compared. Cf. again Sakra II, 345-346. (2) That agriculture¹ is successful which yields a profit twice the expenditure (including Government demand) after duly considering variations in actual produce.

(3) The king should realise 2 (a) one-third from places irrigated by tanks, canals and wells, (b) one-fourth from places irrigated by rains, (c) one-half from riparian soils, and (d) one-sixth from barren and rocky soils.

(4) If people' cultivate new lands and dig tanks, canals, wells, &c., for their good, the king should not demand anything of them till they have realised profit twice the expenditure.

(5) Income of the State from Land or Land Revenue is called *Parthiva*⁴ Income (terrestrial). This is various according to the sources, *e.g.*, natural waters, artificial waters, villages, cities, &c.

(6) The king should give to each cultivator the deed of rent⁵ having his own mark or seal.

(7) The apportionment and realisation⁶ of land-revenue are to be managed in the following way:

(a) Having determined the land-revenue of the village the king should receive it from one rich man in advance, or accept a guarantee for the payment of that in monthly or periodical instalments;

(b) Or the king should appoint officers, called gramapas, by paying onesixteenth, one-twelfth, one-eighth of his own receipts.

(8) If necessary, the king should set apart lands and build houses for peasants."

(9) It is one of the functions of the Sumantra [•] or Finance Minister to study the amounts of land, in cultivation, and out of cultivation, to know the realisers of rent and the amount realised, &c.

(b) The Crops.

In the preceding sketch we have given all that can be gleaned from *Sukraniti* about cultivation, irrigation, out-turns, Government demand and the agricultural class. We shall now proceed to notice the various plants that have been mentioned by the Sukra authors in the course of their work as distinguished from the fruit-bearing and thorny trees enumerated together, as well as their domestic, industrial or artistic uses which have been recorded in the treatise.

Grains are important like the noble metals, precious stones, &c., and should be hoarded in the treasury. It is one of the duties of the king to study the amounts with the chief of granaries for four⁹ muhurtas before meals. These are important belongings of the state and require a department or an officer all

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| ¹ Sukra IV, ii, 224-26. | * Sukra I, 428-424. |
| * Sukra IV, ii, 227-30. | * Sukra IV, ii, 247. |
| ⁹ Sukra IV, ii, 242-44. | ' Sukra IV, ii, 248-52. |
| * Sakra 11, 668-70. | * Sukra II, 207-10. |
| * Sukra I, 561-62. | 1 Muhurta=48 minutes. |

to themselves. He is called dhany fidhipa.¹ His function is to know⁴ of the species, measurements, values, essential characteristics of the grains, as well as the methods of consuming, collecting and cleansing them. It is to be noted that winnowing of grains is a *kalå* or an art, and those who practise it should be maintained by the state.³

The following are the rules⁴ for the collection and accumulation of grains and provisions:

(1) They should be sufficient to meet the wants of three years, or more.

(2) Only those grains are to be stored up which are well-developed, bright, best of the species, dry, new, or have good colour, smell and taste, the famous ones, durable and dear.

(3) Those grains which have been attacked by poisons, fire or snows (hima) or eaten by worms and insects or those that have been sucked hollow should be used for immediate consumption and not laid by for future use.

(4) Every year there should be new instalments to replace those that have been consumed.

It is evident that the superintendent of the granary is to have such qualifications as will enable him to help the king in discriminating the good ones from the worthless. Like the superintendents of metals and gems who are to be well up in Economic Mineralogy, the officers of the granaries are to be proficient in those branches of Economic Botany which deal with the food-grains, cereals, domestic crops, &c, especially with regard to their life-history, diseases, enemies, &c.

It is to be understood that the grains are stored up not only for ordinary uses in the royal household, but also for the commissariat in times of war. "The king should have forts⁵ well-provided with war materials, as well as grains, &c." We have already noticed the importance Sukracharyya attaches to grains in warfare ⁶ "From the manœuvre of asana or besieging, the king should destroy carefully those people who help the enemy by carrying wood, water and provisions; and subjugate the enemy through protracted processes by which provisions at e cut short, food and fuel are diminished and the subjects are oppressed." We read also: "The powerful should coerce' the enemy by stopping the supplies of water, provisions, fodder, grass, &c., in an unfavourable region and then extirpate it."

Besides these references to grains in connexion with the state treasury, royal household, and military operations, there are others which relate to economic interests of people. Thus we have the ruling about joint stock enterprise⁶ in grains, as in metals, &c. Again, like the man who counterfeits coins, the man who destroys grains is said to commit an offence that is called

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| ¹ Sukra II, 299. | * Sokra IV, vi, 28-24. |
| Sukra II, 818-14. | " Sukra IV, vii, 570-78. |
| • Sukra 11, 408-9. | ' Sukra IV, vii, 740-41. |
| " Sukra IV, ii, 50-59, | * Sakra IV, v, 614-18. |
| | |

Rajajneya or cognisable by the state as against itself, even without any plaintiff. This is one of the 22 cases' enumerated by Sukracharyya as coming under crown vs. defendants.

i. The Cereals. (a) Vrihi,

Vrihi (oryza sativa)^a is used in rubbing the oyster-pearl soaked in hot saline water during a whole night in order to test if it is genuine or one of the artificial commodities, e.g., those manufactured by the people of Ceylon. Rice^a is one of the ingredients used in determining the guilt of an offender by Divya sadhana, or divine test. The man has to chew without anxiety or fear one karşa amount of rice. The rice-ordeal would declare a man guilty who in chewing the rice experiences difficulties, through palpitation of heart or want of salivation. This ordeal is to be applied in a case involving theft of Rs. 125.⁴ There is a law also that the king should not receive milk of cows, &c., for his kith and kin, nor paddy⁵ and clothes from buyers for his own enjoyment.

(b) Godhuma.

Wheat (*Triticum vulgare*) has been mentioned only once. The iron-sheet of which the *kavacha* or armour has to be made should have the thickness of a grain of wheat.[•] "This cereal" is essentially a crop of the warmer and drier parts of the temperate zone; but its limits of growth are wide, its varieties being adapted to nearly all climates. In India it is always grown in the cold weather, most extensively in the north and hardly at all in the south."

In Prof. Guha's Bengali translation of Greek Fragments of Megasthenes we read of Strabo quoting from Eratosthenes to enumerate some of the cereals and pulses of India sown in the rainy season and winter, and remark that wheat, barley and other crops are unknown to the Greeks (Strabo, XV. i, 13.)

Mr. Schoff thinks (p. 76) that wheat was introduced into India from Egypt. But according to Mr. Jayaswal, the evidence of language is against this view. It came from Persia, or from Mesopotamia (one of its wild homes) through Persia. Its name in India (Godhuma) is identical with that in Persia (Gandum). Wheat does not figure in Hindu ceremonials, where barley flour and grains are employed. The former is certainly a late introduction.

Mr. Schoff's view was started by Candolle in his "Origin of Caltivated Plants." The section on Habitat and History of wheat in Watt's Dictionary of Economic Products, Vol. VI, Part IV (p. 90-91), summarfses Candolle's remarks. The Editor's remarks are also very valuable: "There is thus very nearly as strong presumptive evidence in favour of India being the home of some of the forms of wheat as can be shown for any other part of the globe. * * * India possesses perhaps as comprehensive a series of time-honoured forms of wheat as can be shown for any other country. Most of these have been grown for countless ages on very nearly the same fields as they are to be found at the present day."

| ¹ Sukra IV, v, 165-166. | ⁹ Sukra IV, v, 476-71, 483. | | |
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| ² Sukra IV. it. 126-128. | " Sukra IV, v. 487-90. | | |

• Sukra IV, ii, 258-54. The reader is requested to read the translation of these lines as given here on p. 149 of Vol. XIII of the Sucred Boots of the Hindus Series. • Sakra IV, vii, 432-33.

' Indian Empire in the Imperial Gazetteer of India. Vel. III. p. 29.

(c) Yava.

Yava or barley (Hordeum vulgare) is the third cereal mentioned in Sukraniti. It constitutes one of the best articles' of horses' food. It is also one of the substances which are to be cooked with water for application to trees whose fruits wither up through disease." The powder of yava should be kept together with other grains and beef as well as water for seven nights. The application of this water also conduces to the growth of trees in flowers and fruits.³

(d) Pulses.

The pulses have been mentioned by the Sukra authors in connexion with the food of horses. Thus we read that barley and chanaka⁴ (gram or Cicer arietinum) constitute the best food for horses; masa (black gram or Phaseolus radiatus) and makustha (Phaseolus acontifolius or kidney bean) constitute second class food; and masura (lentil or Lens esculenta) and mudga (green gram or Phaseolus mungo) are inferior stuff.

Besides these five pulses, we have harimantha⁵ (peas or Pisum sativum) in the following line: "The horse should be given harimanthas, maşas and makuşthas, both dry and wet, as well as cooked meat."

The seventh pulse mentioned in Sukraniti is kululha⁶ (horse gram or Dolichos biflorus). Like barley, it is one of the substances used in the preparation of the manure that operates against the tendency of trees to have their fruits withered up, and promotes the growth of healthy flowers and fruits. The other pulses which may also be thus used are Phaseolus radiatus and Phaseolus mungo.

(e) No Saktu.

Saktu has been mentioned also as a food for horses." "The horse should, after work, be fed upon sugar and Saktu mixed with water." Also, "the horse should be made to take milk, ghee, water and saktu." This Saktu is powdered preparation of *Cicer arietinum* and other pulses or hordeum vulgare, &c.

One other pulse has been referred to. That is nispapa (Dolichos lablab). The two nostrils of an image are to be beautiful like the $nispapa^{\circ}$ legume.

(f) Oil-seeds.

White mustard seeds have been mentioned as representing one of the many shapes of feather-rings which are auspicious marks of horses.

One of the 64 kalâs is the extraction of oil from seeds.¹⁰ We are not told which seeds. The use of oil for the body is referred to in the following : "The man who appears before the king in the act of rubbing oil¹¹ commits the offence called *chkala*.

| ' Sukra IV, vii, 285. | | [•] Sukra IV, iv, 107. |
|-------------------------------------|-------------------------------------|---------------------------------|
| ² Sukra IV, iv, 107-108. | | ' Sukra IV, vii, 270-71, 282. |
| 3 Sakra IV. iv. 118-112. | | ^a Sukra IV, iv, 224. |
| * Sakra IV. vii, 285-88. | | ' Sukra IV, vii, 159-161. |
| * Bakra IV, vii, 272-73. | | 1º Sukra IV, iii, 187. |
| 5 | ¹¹ Sakra IV, v, 155-156. | |
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(g) Tila

Tila¹ (Sesamum indicum) is, like the cereal yava and the pulses, phaseolus radiatus, and phaseolus mungo, and dolichos biflorus, an ingredient to be used for the preparation that conduces to the growth of trees in flowers and fruits. It may be used in two ways either (1) by being cooked or (2) by being powdered and mixed with beef, cold water, &c., and kept undisturbed for seven days and nights. The flower of the plant is very straight; and the nose of images⁴ is to be like it, if straight, or like the bill of birds, if curved.

The following interesting note is taken from Birdwood's Handbook to the Indian³ Court at the Paris Universal Exhibition of 1878: "The phrase Open Sesame is from the Indian oil seed, til, or sesamum indicum, the cultivation of which was carried in the earliest ages into Mesopotamia and Egypt, where it became known under the name of Semsen; and 'open Sesame!' is equivalent to 'Bring in the candles,' 'Light the gas'; bring light, which opens everything, which neither wheat nor barley could give Cassim, but only the oil seed Sesamum."

Mustard (Brassica campestris) has been referred to as the specimen of very small substances. "To the good man even a very insignificant benefit rendered appears very high, while the wicked man considers a service even less in amount than a mustard seed to be huge."⁴

n. Other Plants.

. (a) Sugarcanes.

Sugarcanes⁶ (Saccharum officinarum) are the plants which give rise to one of the sixty-four kalâs. The following is taken from Birdwood's Paris Exhibition⁶ (1878): "Sugar was introduced into Europe by the Saracens and through the Crusades. * * • All the European names for Sugar are derived from Sanskrit Sharkara, through the Arabic Shakar, the Hindu name of sugar. * * * Undoubtedly sugar was made from time immemorial in India. * * Nearchus quoted by Strabo (XV. 1, 20) says that in India 'reeds yield honey, although there are no bees.'

(b) Bamboos.

Bamboos' (Dendrocalamus strictus) also give rise to a kala—the preparation of vessels with leaves and straws of the plant. Bamboos are known to be one of the sources of pearls.⁶ It is also stated that the king should win over the forest tribes to his side, and be like bamboos⁶ surrounded by clusters of thick thorny trees.

(c) Tula or Cotton.

Cotton (Gossypium herbaccum) has been referred to twice to serve the purpose of analogies for light insignificant substances. "The untrained, inefficient and raw recruits are like bales of cotton.¹⁰ The wise should appoint them to other tasks besides warfare." Again, "The king cannot be restrained by the councillors, for they are his servants, just as the elephant cannot be bound by thousands of bales of cotton."¹¹

| ¹ Sukra IV, iv, 107-168, 110-112, | P. 24 |
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| ² Sukra IV, iv, 223. | 4 Sukra III, 619-20. |
| See pp. 31-33, for the interesting history o | f sugar in both East and West. |
| • Sukra IV, iii, 146. | ¹ Sukra IV, vii, 482-85. |
| * Salera IV, dii, 190. | ¹⁰ Sukra IV, vii, 856-857. |
| * Sukra IV, 1, 117-18 | ¹¹ Sukra IV, vil, 882-885. |

Mr. Schoff in his newly published edition of the Periplus (Pp. 71-76) adds the following note :

"Sansrkit, kårpåsa : Hebrew, carpas : Greek, karpasos : Latin, carbasus-the seedfibres of Gossypium herbaceum and G. arboreum (order, Malvaceæ) native in India, and weven into cloth by the natives of that country before the dawn of history. The facts concerning it have been admirably stated by Mr. R. B. Handy in The Cotton Plant, a report of the U.S. Department of Agriculture, issued in 1896. Cotton thread and cloth are repeatedly mentioned in the laws of Manu, 800 B.C. Professor A. H. Sayce in his Hibbert Lectures shows ground for the belief that it was exported by sea to the head of the Persian Gulf in the 4th Millennium B.C.; and it found its way very early to Egypt. Herodotus describes it as a wool, better than that of sheep, the fruit of trees growing wild in India.

"The manufacture of cotton cloth was at its best in India until very recent times. and the fine Indian muslins were in great demand and commanded high prices, both in the Roman Empire and in Medizeval Europe. The industry was one of the main factors in the wealth of ancient India, and the transfer of that industry to England and the United States, and the cheapening of the process by mechanical ginning, spinning and weaving, is perhaps the greatest single factor in the economic history of our own time."

In Prof. Rajanikanta Guha's Bengali translation of the original Greek Fragments of Megasthenes we read of Eratosthenes referring to wool yielded by a kind of tree. Prof. Guha also mentions Herodotus as having noted this fact, and remarks that this undoubtedly points to karpasa or cotton plant.

Prof. Mookerji quotes from the eighth volume of Nihon-ko-ki and 199th Chapter of Ruijukokushi, two Japanese State records, to prove that about 799-800 A.D., "Cotton was introduced into Japan through the Indians who were unfortunately carried over to that country by the black current." Indian Shipping, p. 174.

(d) Arka.

Besides cotton, another fibre-plant has been noticed. This is arka (Calotropis gigantea), but its use in Sukranili is for a quite different purpose.

The Calotropis gigantea, the Euphorbia neriifolia, Allium saturam, Indigofera tinctoria, and Pinus longifolia have been mentioned as plants useful in the manufacture of gunpowder," as supplying both charcoal and juice. We have already described the recipes in the section on minerals.

(e) Indigo.

The antiquity of Indian Indigo can be inferred from the following lines in the History of Indian Shipping (p. 91): "Further, according to Wilkinson, the presence of indigo, tamarind wood, &c., has been detected in the tombs of Egypt, and Lassel has also pointed out that the Egyptians dyed cloth with indigo." (1) Betel.

Among narcotic plants we have betel (Piper betle) and ganja (Cannabis The preparation and preservation of betels constitute one of the sativa). sixty-four kalas." Men skilled in the preparation of betels" have been mentioned among the artists and artisans who should be encouraged by the king.

¹ Sukra IV, vii, 400-415. ² Sukra IV, iii, 198. ³ Sukra II, 410-11.

^{*} See Birdwood's Paris Universal Exhibition, p. 28.

One of the chhalas or offences against social etiquette is known to be the act of taking or chewing betel, ¹ before being presented with it by others.

Betel-leaf has ever been an important item in the socio-economic life of South India. We have seen the trade in betel mentioned by *Periplus*. An inscription' bearing on mediæval Chola life (800-1100) records: "The great men elected for the supervision of the tanks shall be entitled to levy a fine of one Kalanju of gold in favour of the tank-fund, from those betel-leaf sellers in this village, who sell betel-leaf elsewhere but at the temple of Pidari."

(g) Gânjâ.

The ganja house has been mentioned as a generic term for taverns and resorts of people who take to spirituous liquors, intoxicants, narcotic drugs, &c. "The king should build the ganja house³ outside the village and there keep the drunkards, and should never allow drinking of liquor in his kingdom in the day time."

No intoxicant plant has been referred to in the Sukraniti as such, but we have noticed in a previous section that Cocos nucifera, Phœnix sylvestris, &c., are such liquor-yielding plants. Tobacco (Nicotiana tabacum), Poppy (Papaper somniferum), &c., have not been mentioned.

(h) Lotus.

Lotus or Nelumbium speciosum is the plant whose flowers are the favourite resorts of bees. "The bee that has the power of cutting holes and can fly with wings, gets, however, caught within a lotus,⁴ because of its desire for smell." Lotuses,⁸ when newly blossomed, are favourites of the moon also. Lotus is one of the things in the hands of Visnu. "The sattwika form of Visnu's image is to have hands indicating blessings and courage, and possessing conch and lotus."⁶ The lotus is sacred also to the gods, Sun and Ganesa.

(i) Citron.

Matulunguka or citron (Citrus medica) is the plant which, like lotus, is sacred to the gods." A fruit of this plant is to be placed in one of the four hands of Laksmi."

(j) Rati (Abrus precatorius).

Ksuma[®] and rali are seeds important in measurement of metals, precious stones, &c. The standards of weights and measurements will be treated of at length in a subsequent chapter.

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¹ Sukra IV, v, 153-154.

^{*} Aiyangar's Ancient India p. 161.

[.] Sukra IV. iv, 89-90.

^{*} Sukra I, 211-212.

[•] Sukra I, 828-824.

^{*} Sukra IV, iv, 296, 301-302, 275-278, 298-99.

^{&#}x27; Sukra IV, iv, 275-278.

[•] Sakra IV, iv, 300.

^{*} Sukra IV, ii, 180-144.

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SECTION 7.

Bolany as Science.

Elementary notions of Theoretical Botany are to be met with here and there. Thus we are taught that "inferiority and superiority¹ depend sometimes on the qualities of the seed, sometimes on the character of the field. But excellence is due to both." This is all that we have of *abstract* Ecology.

According to size and shape we have the following classes of plants, besides trees :

- (1) Latah," which do not flourish without resting grounds.
- (2) Stambinyah' or bushes.
- (3) Gulminyah.4

The trees are (1) thorny and (2) fruit-bearing; or (1) wild and (2) domestic. This is the sole Dendrology of the Sukra authors.

All the seven parts of a plant are known and have been mentioned in the right scientific order, *e. g.*, root, stem, branches, leaves, flowers, fruits and seeds. Thus "the king is the root of the state, the councillors are the stems or trunks, the commanders are the branches. The troops are the leaves and flowers; the subjects are fruits, and the lands are seeds." Of course the fanciful analogy between the vegetable organism and the political organism is to be taken for what it is worth. It has its parallel in the fictitious analogies drawn between the body politic and other organisms by mediæval political thinkers of Europe.

The importance of the root in the life-scheme of the plant is thus indicated: "Just as the branches of a tree wither up when its roots⁴ decay, so also without the king, the commanders, &c., grow powerless immediately or in course of some time."

Sukra statesmen know of only one form of political organism—the monarchical. And therefore the loss or absence of the king means a decay, if not complete revolution, of the kingdom.

The root has occupied an important place in the history of Botany in the west also.

"Throughout the whole period of Greek antiquity' there was a class of men who followed as a regular business the gathering, preparing and selling of roots and herbs that were of repute in medicine. * * * It was the example of the rhizotomists, in their books of plant-description extant in the times of Aristotle and Theophrastus, that impelled Theophrastus and others after him to give the form, texture, colour, odour, flavour, as well as the active properties, when these were known, of the roots or underground part of almost every

| * Sukra IV, iv. 78-79. | • Sukra IV, iv, 91-93. | |
|------------------------|------------------------------|----------------------------|
| * Sukra 1. 767. | • Sukra V, 24-26. | 3 |
| Sukra IV, iv, 128. | ' Sukra V, 22-8. | .* |
| Sukra IV, iv, 125 | • Greene's Landmarks of Bota | inical History, pp. 48-51. |

plant. ** From Dioscorides and Pliny down through the middle ages and out to near the end of the seventeenth century authors in general described and figured the roots of every weed and grass and bush and tree. ** It was Valerius Cordus, the greatest if not the only botanical genius of the first half of the 16th century, who first gave expression to the opinion, that, from the morphologic and phytographic point of view, the importance of the root had always been over-estimated. He set the example for a reform of descriptive botany in this particular; but, as usual with men of genius, he was a century in advance of the ideas of the multitude."

SECTION 8.

A Preliminary Survey of Hindu Botany.

1. Lines of inquiry.

The data of ancient Indian Botany from the Nitisåstra of Sukråchåryya have supplied us with information regarding the knowledge of the Hindus in several branches of Economic, Utilitarian or Applied Botany, *e.g.*, Sylviculture, Horticulture and Agriculture. The authors of the Sukra cycle have mentioned also the botanical Kalås or vegetable arts and industries auxiliary to Ayurveda, the Science of Medicine, but have not otherwise devoted much attention to the Medical branch of Economic Botany. We have noted likewise that for Theoretical Botany or Botany as an abstract science, Sukraniti furnishes very few materials and has thrown out only vague hints here and there. This is inevitable, since the subject of plants and plant-life touches the province of Nitisåstras solely from the utilitarian stand-point.

If we take "the most extended use of the term, all information about the plant-world or any part of it is Botany.¹ According to this view, all treatises upon agriculture, horticulture, floriculture, forestry, pharmacy, in so far as they deal with plants and their products, are botanical." All earlier historians^{*} of Botany in Europe have proceeded to their work on the theory "that for the earliest intimations of anything looking in the direction of the science of botany we must have recourse to those oldest pieces of literature in which plants are more or less freely mentioned. Adanson, for example, does not begin botanical history without naming Orpheus, Musa, Solomon, Hesiod, Homer, Metrodorus, and Hippocrates, who as poets or physicians wrote of plants. Sprengel has among his initial chapters one bearing the title 'flora Biblica,' another 'flora Homerica,' another 'flora Hippocratica.'"

The historian of Hindu Botany may, therefore, safely look upon Vedic Literature, Charaka Samhita, the Astadhyayi of Panini, the Ramayanam, the Mahabharatam, the Jatakas, the Puranas, the Tantras, the scientific works of the schools of grammar, astronomy, medicine, and lexicon, the poetical works of Bhasa, Kalidasa and others, the Nitisastras, and other treatises of Sanskrit

¹ Landmarks of Botanical History, Part I. By Edward Lee Greene (Published by the Smithsonian Institution, U. S. A. 1909) Preface p. 7.

² Ibid. Chapter I. p. 20.

literature as important landmarks in the history of knowledge regarding plants, and give to some of his chapters such titles as 'flora Vedic,' 'flora Charakensis' 'flora Malwica,' 'flora Sukrensis,' and so on

Botany, as a science, however, must rigidly demarcate itself from such ,utilitarian or poetic treatment of plants, but occupy itself with the "contemplation¹ of plant as related to plant and with the whole vegetable kingdom as viewed *philosophically* in its relation to the mineral on the one hand, and to the animal on the other." Such purely botanical studies *i.e.*, abstract researches regarding plants as *plants* rather than as things useful or deleterious to man and beast, are pre-eminently modern. This would be evident from the following extracts from the articles bearing on the history and evolution of the science in *Encyclopaedia Britannica*:⁶

"Little, however, was done in the science of Botany, properly so called. until the 16th century of the Christian era, when the revival of learning dispelled the darkness which had long hung over Europe. *** The descriptions in these early speculations were encumbered with much medicinal detail, including speculations as to the virtues of plants. Plants which were strikingly alike were placed together, but there was at first little attempt at systematic classification. * * * The foundation of botanic gardens during the 16th and 17th centuries did much in the way of advancing botany. They were at first appropriated to the cultivation of medicinal plauts. This was specially the case at the Universities where medical schools existed. * * * Robert Brown (1773-1858) was the first British botanist to support and advocate the natural system of classification. * * * The .study of plant anatomy was begun in the middle of the 17th century as a direct result of the construction of microscopes. * * * The subject was practically dormant for nearly a century and a half: it was revived by several German workers * * * at the beginning of the 19th century, * * * The pioneer of modern plant anatomy was Hugo von Mohl (1840). * * * In its systematised form, as a branch of botanical study. Phytopathology is of recent date; and, as now understood, the subject first received special attention about 1850, when the nature of parasitism began to be intelligible.3

"One of the earliest workers at Plant Physiology⁴ was Hales (1727). *** The birth of Modern Chemistry in the work of Priestley and Lavoisier, at the close of the 18th century, made possible the scientific study of Plant-nutrition ••• The department of geographical Botany made rapid advance by means of various scientific expeditions which have been sent to all quarters of the globe, as well as by individual effort since the time of Humboldt."

The above extracts regarding Systematic, Physiological, Geographical

¹ Ibid. Preface. p. 7.

^{* 11}th Edition Vol. 4, p. 299.

[•] Vol. XXI, pp. 748-5, 754.

⁴ Vol. IV. p. 202.

and Anatomical branches of Botany,¹ considered as an abstract science, show the essentially modern character of this division of human learning. Botany, as we have it to-day, is in reality only as old as the second decade of the last century. In comparing botanical ideas of the Hindus with those of the western peoples we cannot, therefore, too carefully remember the fact that these are embodied in Sanskrit treatises which are mostly several centuries older than even the crude beginnings of European scientific thought due to the Renaissance of the 16th century.

Whatever be the value of Hindu botanical theories, they are well worth the attention of the historian of botanical science for a proper estimate of the mile-stones in the culture-history of mankind. The data of botany as science from Hindu literature would thus supply some of the missing links in the concatenation of diverse facts and ideas that go to make up the complex web of human civilisation.

We have noticed above that in Europe botany began and grew as the handmaid of, and in subordination to, the science of medicine. The story is repeated in India also. The botanical literature of the Hindus is mainly pharmacopical, and essentially utilitarian or economic, at times poetical, scarcely scientific. And yet it is possible to glean from the vast mass of literature on industrial or applied botany and horticultural recipes the really scientific conceptions of the Hindus regarding (1) Vegetative organography, (2) Anthology, (3) Fruit and seed, (4) Anatomy, (5) Phytography, (6) Taxonomy, (7) Nomenclature, (8) Ecology, and (9) Dendrology.

Thus, according to Greene, "there are certain rudiments of a *science* of botany in those ancient pieces of literature, the real substance of which those authors of botanical commentary on the Bible, on Homer, on Virgil, and the classics generally, have completely overlooked. Let me repeat it that in several pieces of very old literature there are legible traces of a science of botany."^a For, consciously or unconsciously, scientific botany must be as old as human history, and as extensive as the races of men. The records of antiquity³ as well as of the most untaught people of modern times afford abundant proof of the existence of organology of plants, systematic botany &c.

By laborious researches into the botanical literature of antiquity, Mr. Greene has traced the evolution of Scientific Botany through the usages and rites of the *rhizotomi* or root-gatherers to the *Historia Plantarum* of Theophrastus (B. C. 370-286) whom he holds up as the "maker of the first landmark in the history of Botany," and "the discoverer and first promulgator of the elements of universal botany."

¹ See also the English Edition of History of Botany (1530-1860) by Prof. Sachs of Wurzburg (Clarendon Press, Oxford 1890). Book I. History of Morphology and Classification, pp. 8-13; Book II. History of Vegetable Anatomy pp. 219-229; and Book III. History of Vegetable physiology, pp. 859-76. Greene's Landmarks (Part I) is a study of certain epochs in the Development of the Science of Botany prior to 1562.

^{*} Landmarks, pp. 20-21.

^{*} See Greene's Landmarks, pp. 21-48 for evidences.-

It may be possible, by following the self-same method in the investigation of the botanical documents of Indian literature, to bring out the contributions of the ancient Hindus to the universal scientific botany of to-day. And probably Greene's remark' about Theophrastus may have to be applied with equal Cogency to charaka and other founders of the schools of medicine in the Pre-Buddhistic and Buddhistic ages of Indian history (6th cent. B. C.):-

"To me it seems not improbable that historians of the future, learning to know this great founder's mind better than is yet known, may agree in some judgment not unlike this: that all that has been added to the understanding of Plant life and form—to morphology, anatomy, physiology, perhaps even to taxonomy—within the last three centuries—has been due to the inventions of the opticians, and to the increased number of students and investigators, rather than to the appearing on the botanical horizon, within the modern period, of any one mind in powers of observation, penetration, and sagacity superior to Theophrastus of Eresus."

2. The so-called " Indian Botany " of to-day.

To do for ancient Hindu sages what Mr. Greene has done for Theophrastus would require (1) a knowledge of the fundamental principles of modern scientific Botany, and (2) a thorough familiarity with the several branches and landmarks of Indian Literature. Unfortunately, the trend of University Education in modern India has been to absorb the whole attention of the student-folk in mastering the technicalities of a foreign tongue; and, while it has deprived them of sound scholarship in oriental subjects, it has not equipped them with genuine mastery in any modern European science. And so far as Botany is concerned, it has until recently been grossly neglected, whether in its theoretical or economic and applied branches. The result has been a complete absence of interest on the part of Indians in things Botanical, abstract or utilitarian, modern or ancient.

When Europeans began to study the plants of India, they did not naturally care to inquire into the traditions of Hindu Botany and could not at all be interested in developing what the children of the Indian soil had achieved in this department of learning in the days of yore. They came out to India as medical men, botanists, or foresters and industrialists, and found in India a rich field for applying or correcting and modifying the systematic and ecological ideas that obtained currency in Europe of the later 18th and

[&]quot;To those who would take up the historical investigation into the really scientific contributions of the Hindus in the field of Abstract Botany, the chapter on *Theophrastus* in Greene's Landmurks is invaluable as suggesting not only the methodology, but also the lines of inquiry that would be required to bring into forefront the hitherto neglected pioneers of science. It is remarkable that Theophrastus, whom Greene elevates to the dignity of "Father of Botany" in 1909, was only casually noticed by Dr. Sachs in his celebrated History of Botany, published in 1875, which the translator for Clarendom Press, Oxford, regarded as a "masterly sketch" even in 1890.