Indigenous plantlore is a manifestation in a given community, based on adaptation and wisdom of local people and environment. It develops over times and continues so also. This treasure of traditional knowledge is used to sustain the community and its bioculture. In long past, people of great understanding, christalized their wisdom in some treatises such as the Panini's Astadhyayi. This treatise is understood and well known for the genesis and development of Sanskrit knowledge. Ancient Sanskrit scripts usually contain information concerning culture and sustenance based on plant world. The present author analysed it in view of plant invasion on Indian landmass in Panini's time. Total 45 exotic plant species belonging to 44 genera and 29 angiospermic families are divulged from it. These belong to nearly all corners of the Old and New Worlds. Majority of them (28 species) are cultigens and still continue even in modern period in India. Of course, rest of them are wild, naturalised and presently constitute integral part of Indian biodiversity. The importance of such ancient treatises is dilated in this communication.

Keywords: Panini's Astadhyayi, Exotic Plants, Invasion, India
INTRODUCTION

Panini (520 BC–460 BC.) was a Sanskrit grammarian, philologist and a revered scholar in Ancient India. He was born in Shalatula, a town near to Attack on the Indus river in present day Pakistan. He is regarded the forerunner of the modern language theory. ‘Astdhyayi’ is a treatise composed by Panini. It consists of eight chapters (Ashata–eight). He gave about 4000 sutras (rules) and virtually built the whole structure of the Sanskrit language. This treatise contains many-sided data pertaining to social, literary, religious, political and geographical aspects of the ancient India. It is a reliable source of Indian history. This treatise sheds light itself on the life and thought of the population of ancient India. Obviously, life of the then Indians was interwoven with some elements of biodiversity. The present author, therefore, thought worth to throw light on plant species with particular emphasis on exotic ones which are indicative of plant introduction, naturalisation and ultimately plant invasion on the Indian subcontinent in Panini’s time.

METHODOLOGY

The treatise by Panini and is available through the works of Sharma (1987) and Agrawal (1953). Information was borrowed and critically examined to tap down floral wealth contained in them. The Sanskrit plant names are equated carefully to the updated botanical names and families. The plant species were studied to know particularly their exotic status. Exotic status is ascertained by consulting relevant taxonomic literature mentioned against each species in the Table-I. The species are also analysed regarding cultivated status or wildness. The data accrued is discussed to reveal plant invasion in the then India.

RESULTS AND DISCUSSION

A large number of accounts on Indian biodiversity have been published in recent times inclusive of regional and local studies. While botanizing floristically, wild and naturalised exotic species are documented but exotic plants of agricultural, horticultural or ornamental significance are generally ignored. The exotic species form quite a good percentage in India (Maheshwari, 1960, 1979; Nayar, 1977; Reddy, 2008). Floristic studies, of late, are focussing on plant invasion in different regions in India. However, plant invasion and its history in ancient period have not received adequate attention. The present author made a headway in this direction (Patil, 2017a, b, 2018a, b; 2020). The present account is a similar attempt to focus a much-neglected ancient treatise which contains floral elements in Sanskrit form. These elements are deciphered with the help of relevant taxonomic literature and also ascertained for their exotic status.

Analysis of information accrued from the said treatise revealed total 45 angiospermic species belonging to 44 genera and 29 families. Of these, the dicotyledonous exotic species have major share in plant invasion in the erstwhile India (37 species, 39 genera, 27 families). The monocotyledonous ones have lesser contribution (08 species, 08 genera, 02 families). They belong to different habitat categories as trees (13), shrubs (04), climbers (07) and herbs (21).

The herbaceous species contributed significantly as compared to other categories. The figure in parenthesis denote number of exotic species. Interestingly, majority of exotics (28 species) are found under cultivation even in modern period. Wild ones have fair representation (15 species). There are two exotic species which are found wild as well as cultivated (Table-I). Plant species, particularly exotic ones, invade a geographical region for two reasons. First, they are introduced by mankind intentionally to add in their daily sustenance or sometimes to supplement their routine necessities. Secondly, plant species migrate naturally as they evolve and adapt certain morphological features to aid their dispersal to long distances. However, some species are also added by mankind due to his negligence while introducing cultivated plant species or trade and travel. Biotic and abiotic factors also play their role in plant dispersal in a region.

The Table-I indicated as many as 25 continents, geographical regions, islands or countries that contributed exotic species. Maximum exotic species are hailed from various parts of Old and New Worlds, in descending order, are: (i) Asia (Excl. India) (16), (ii) Africa (12), (iii) Europe (08), (iv) America (07) and (v) Mediterranean region (05). Some regions contributed as such: China (03), Persia (02) and Arabia (02). Many countries or regions shared just a single exotic species. These are Fertile Crescent, West Indies, Afghanistan, Baluchistan, Australia, Philippines, Middle East, Cochin China, Malay Islands, Madagascar, Brazil, Bali, East Indies, Paleotropics, Subtropics and warm temperate zone, Tropical and subtropical regions of both hemisphere.

An omnipresent role of plant world in various human societies world over needs no special mention. Plants have been a dominant source in food, medicine and miscellaneous human necessities. Plantlore in ancient times generally passed on by word-of-mouth as a tradition prior to the technologies and skills developed for writing. Gradually, primitive methods were developed e.g. writing on leaves or barks of plants. Historical records are testimony to such an evolution. Evolution of language is another arena which progressed eventually. Panini’s Astadyayi is one such ancient Indian treatise which
crystallized the Sanskrit language in rule form and also contained information from nearly all compartments of knowledge and social practices prevalent in the time of Panini. Such evidences are rare and sporadic which pass on knowledge if analysed carefully and critically. The aforesaid information is restricted only to plant world. It is of help to understand economy, social needs and plant invasion on Indian subcontinent in the long past and hence should not be ignored. The information on plant species is still valuable. It informs Indian contacts and trade with other world, besides socio-cultural conditions and evolution of linguistics. It enriches our fund of data for our well-being.

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| Sr. No. | Plant Species & Family | Sanskrit Name | Wild (W) / Cultivated (C) | Habit | Native Region or Country |
|---------|------------------------|---------------|--------------------------|-------|--------------------------|
| 1.      | Achyranthes aspera L. Amaranthaceae | Pratyakpuspa | W H | Tropics: Medakkar & Sharma, 2016. |
| 2.      | Ailanthus excelsa Roxb. Simaroubaceae | Aratu | W T | America: Kotresh & Siddheshwari, 2020. |
| 3.      | Albizia lebbeck (Linn.) Benth. Mimosaceae | Sirisha | C T | Pantropical Africa & Tropical Asia: Bhandari, 1978. |
| 4.      | Bauhinia variegata L. Caesalpiniaceae | Kovidar | C T | China: Debnath & Debnath, 2017; Pulliaah & Ramamurthy, 2001. |
| 5.      | Boerhavia diffusa Linn. Nyctaginaceae | Varsabhu | W H | Tropical Africa: Panda, et al., 2018. |
| 6.      | Bombax ceiba Linn. [Syn. Salmalia malabarica (DC.) Schott. & Endl.] Bombacaceae | Shalmali | W T | America & Australia: Mukhopadhyay & Chakrvarty, 2008. |
| 7.      | Borassus flabellifer L. Areaceae | Tala, Tal | C T | Tropical Africa: Reddy, 2008; Chandra Sekar, 2012. |
| 8.      | Brassica campestris Linn. var. sarsen Pratin Barassicaceae | Sarsap | C H | Europe: Naqshi & Javeid, 1987. |
| 9.      | Calotropis gigantea (L.) R. Br. Asclepiadaceae | Prakpuspa | W S | Tropical Africa: Reddy, 2008; Patil, 2017. |
| 10.     | Calotropis procera (Ait.) R. Br. Asclepiadaceae | Ark | W S | Tropical Africa: Reddy, 2008; Patil, 2017. |
| 11.     | Cannabis sativa L. Cannabaceae | Bhanga, W,C | H. | Central Asia: Chandra Sekar, 2012. Asia (Excl.India): Kaul, 1986. |
| 12.     | Carthamus tinctorius Linn. Asteraceae | Maharjan | C H | South-West Asia: Patil, 2003; Singh et al., 2001. |
| 13.     | Cassia fistula L. Caesalpiniaecae | Vyadhighat | C T | North America: Debnath & Debnath, 2017. Tropical Asia: Mukhopadhyay & Chakrvarty, 2008. |
| 14.     | Citrullus colocynthis (Linn.) Schrad Cucurbitaceae | Gavadani | W C | West Africa: Sainkhediya, 2016. |
| 15.     | Citrus reticulata Blanco Rutaceae | Narang | C T | Philippines: Singhe et al., 2000; Almeida, 1996. Asia (Excl. India): Stewart, 1972. |
| 16.     | Coccinia grandis (L.) Voight Cucurbitaceae | Bimbi | W,C | Africa: Titiek et al., 2015; Medakkar & Sharma, 2016. |
| 17.     | Coix lacryma-jobi L. Poaceae | Gavedhuka | W H | Tropical Asia: Singh et al., 2015. |
| 18.     | Coriandrum sativum L. Apiaceae | Kustumburu | C H | South Europe: Yadav & Sardesai, 2002. Mediterranean Region: Shetty & Singh, 1987. |
| 19.     | Eleusine indica (L.) Gaertn. Poaceae | Balvaja | W H | Africa, Temperate & Tropical Asia: USDA-ARS, 2014. |
| No. | Species                                                                 | Family          | Native Region                                                                 | Authors                                                                 |
|-----|-------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| 20. | *Foeniculum vulgare* Mill.                                                  | Apiaceae        | Shatapuspa                                                                    | South Europe: Gaikwad & Garad, 2015; Shetty & Singh, 1987. Mediterranean Region: Purseglove, 1968. Europe: Dar et al., 2002. |
| 21. | *Gossypium herbaceum* L.                                                   | Malvaceae       | Karpas                                                                        | Arabia & Asia Minor: Bailey, 1949. Africa & Asia: Purseglove, 1968.     |
| 22. | *Hordeum vulgare* L.                                                       | Poaceae         | Yava, Yavak                                                                   | Europe: Dar et al., 2002.                                              |
| 23. | *Imparata cylindrica* (L.) Rauesch. Poaceae                               |                 | Darbha                                                                        | Tropical America: Debnath & Dabnath, 2017; Reddy, 2008. Asia (Excl. India) & Europe: Kaul, 1986. Tropical Asia: Titiek et al., 2015. |
| 24. | *Lagenaria siceraria* (Mol.) Standl.                                      | Cucurbitaceae   | Pindophala                                                                    | Africa: Singh & Nigam, 2017.                                           |
| 25. | *Lawsonia inermis* L.                                                      | Lythraceae      | Nakharanjani                                                                  | Middle East: Gaikwad & Garad, 2015. Arabia & Persia: Shetty & Singh, 1987. |
| 26. | *Lens culinaris* Medik. (Syn. *Ervum lens* L.) Papilionaceae               |                 | Masura                                                                        | Mediterranean Region & West Asia: Shetty & Singh, 1987. Central Europe, Mediterranean Region & West Asia: Patil, 1995. |
| 27. | *Linum uttitissima* L.                                                     | Linaceae        | Uma, Atasi                                                                    | Mediterranean Region: De Candolle, 1959. Europe: Dar et al., 2002.     |
| 28. | *Luffa acutangula* (Linn.) Roxb. Cucurbitaceae                            |                 | Koshataki                                                                     | Tropical Asia: John, 1891.                                             |
| 29. | *Macrotyloma uniflorum* (Lam.) Verdc. (Syn. *Dolichos biflorus* Auct. non L.; Syn. *D. uniflorus* Lam.) Papilionaceae |                 | Kulatttha                                                                     | South-East Asia: Patil, 2019.                                          |
| 30. | *Moringa oleifera* Lam.                                                    | Moringaceae     | Shigru                                                                        | America: Singh & Srivastava, 2000.                                     |
| 31. | *Nerium indicum* Mill.                                                     | Apocynaceae     | Karvir                                                                        | Mediterranean Region: Singh et al., 1991; Purseglove, 1968. China, Cochin China: Voight, 1845. |
| 32. | *Panicum miliaceum* L.                                                     | Poaceae         | Anu                                                                            | Asia (Excl. India): Kaul, 1986.                                        |
| 33. | *Phyllanthus acidis* (Linn.) Skeels [Syn. *Cicca acida* (Linn.) Meril] Euphorbiaceae |                 | Lavani                                                                        | Malay Islands & Madagascar: Singh et al., 2001. North-East Brazil: Panda & Das, 2004. |
| 34. | *Piper betle* Linn.                                                        | Piperaceae      | Tambul                                                                        | Bali & East Indies: Graf, 1980.                                        |
| 35. | *Pistacia chinensis* Bunge                                                | Anacardiaceae   | Shringi                                                                        | China: Mingli Tang et al., 2012.                                       |
| No. | Species | Family | Distribution |
|-----|---------|--------|--------------|
| 36. | *Punica granatum* L. | Punicaceae | Dadima | C | T | Afghanistan, Baluchistan & Persia: De Candolle, 1959; Patil, 2003; Shetty & Singh, 1987. |
| 37. | *Rubia cordifolia* L. (Syn. *R. manjista*) | Rubiaceae | Majuastha | W | C | Asia (Excl. India) & Africa: Kaul, 1986. |
| 38. | *Saccharum spontaneum* L. | Poaceae | Kasa | W | H | Tropical West Asia: Reddy, 2008; Patil, 2017. |
| 39. | *Sesbania bispinosa* (Jacq.) W.F. Wight | Papilionaceae | Itkat | W | H | Tropical America: Reddy, 2008; Patil, 2017. |
| 40. | *Sida cordifolia* Linn. | Malvaceae | Shvetapaki | W | H | Tropical & Subtropical Regions of Both Hemispheres: Bhandari, 1978. |
| 41. | *Solanum virginiannum* L. (Syn. *S. jacquinii* Miq.) | Solanaceae | Kantakar | W | H | Paleotropical: Singh & Srivastava, 2000. |
| 42. | *Tamarindus indica* Linn. | Caesalpinioideae | Tintidok | C | T | Tropical America: Shetty & Singh, 1987; Patil, 1990. Africa: Pullaiah & Ramamurthy, 2001; Panda & Das, 2004. |
| 43. | *Triticum aestivum* L. | Poaceae | Godhuma | C | H | Fertile Crescent: Singh & Nigam, 2017. |
| 44. | *Vitis vinifera* L. | Vitaceae | Draksha | C | C | South-East Europe To West Indies: Singh et al., 2000. West Asia: Gaikwad & Garad, 2015. |
| 45. | *Ziziphus jujuba* Mill. | Rhamnaceae | Badara | C | T | Subtropics & Warm Temperate Zone: Martin et al., 1987. |