A study of two species of Genus *Prosopis* – *P.Cineraria* and *P.Juliflora*

The Genus of trees *Prosopis* is very fascinating for its extraordinary survival and growth characteristics, in Arid regions. The Ecological and Social utility of *Prosopis* varies from species to species. The variation of the species properties is wide, at one end of usefulness spectrum one species is considered sacred; very useful to the society as well as the ecology, whereas at the other end another species is invasive from ecological perspective but community has made adaptive space for limited usage of this tree. The purpose of this essay is to present the contrasting dimension of two species of trees belonging to the same Genus; adapted to similar regions, with contrasting anthropological and ecological acceptance. In a self destructive mode, the invasive species is slowing eliminating the native species of the same family. I will also try and present a few very special adaptation of this tree genus which makes it suitable for both the community as well as ecosystem. For this paper, I do not intend to present the biological differences but concentrate on their adaptability features for the ecosystem and the community. It could be worth exploring what makes two species of the same genus and family compete and show supremacy at ecological level, but still have a varied degree of acceptance at the community level.

**Regions**

Arid regions are characterized as having extremely dry climate with low and erratic rainfall, with varying levels of atmospheric humidity and high wind velocities. In India the region prominent in this respect is the state of Rajasthan, but is not restricted to only west. Almost every state has a Zone, natural or created due to anthropological reasons which have similar characteristics. In India mainly Rajasthan, Haryana, Punjab, Gujarat, Western Uttar Pradesh, drier parts of Deccan extending as far as South in Tuticorin represent this region (Robertson S, Narayanan N, Deattu N, Ravi Nargis N R, 2010). The trees in these zones need special adaptation to survive the low water levels and high temperature.

**Prosopis Genus**

The genus *Prosopis* belongs to the family *Leguminosae*, subfamily *Mimosaceae* and comprises about 44 species distributed mainly in dry regions of Southwest Asia, Africa and,
predominantly America from western North America to Patagonia. The commonly used term “mesquite” includes leguminous trees of genus Prosopis. The leguminous trees are known for their capability to Fix Nitrogen in the soil and serve the purpose of promoting better soil health. However, this feature is not universal, as I will try to show that one of the species of the family being detrimental to the ecosystem (Khatri, Rathore, Patil, 2010).

Prosopis is a Genus of flowering plants in the pea family, Fabaceae. They often thrive in arid soil and are resistant to drought, on occasion developing extremely deep root systems. Their wood is usually hard, dense and durable. Their fruits are pods and may contain large amounts of sugar. (Prosopis, 2014)

**Water Stress resistance**

We have been witness to trees withering and dying off in stress conditions, low water and dry heat with the trees flowering only in ideal conditions. However, one very striking feature of Prosopis species is the physiological trait of having its partitioning into reproductive organs which are stimulated rather than inhibited by drought stress (Felker, 2009). This means, under the conditions of drought the species actually produces more flowers and fruits, probably using stored reserves. From the tree’s perspective it is viewing the stress as a lower probability of propagation of seeds and hence produces more seeds. This is a useful feature from community angle as the seeds are food for the livestock and in drought when other forms of food are non-existent, more food produced by this tree acts to save them from starvation. Since the tree is dependent on the faeces of the livestock animals for disbursement of the seeds, it serves the dual purpose for the livestock and the tree. The tree population explodes after a drought; a drought being favourable for invasiveness. The changing climate due to anthropological reasons could be a factor which is a positive contributor to the invasiveness. The drought season expands the reproduction capability and the following rainy season help produce more food and store for the next drought; with every seasonal change the invasiveness increases.

**Root System Adaptation**

While Prosopis roots are claimed to reach a depth of 53 Metres (Felker, 2009), the author also is not suggesting correlation between the tree height or growth with deeper
roots. So the probable factor has to be stability of the tree in high winds or erosion of sand conditions prevalent in deserts. It is also interesting, that the depth of roots as compared to the height of the tree of 6-8 metres is many times more which is an indicator of the poor ground strength of the soil. The same species in wet conditions do not grow deep roots.

**Extraordinary survival with low Phosphorus**

It is a common understanding that high level of Phosphorus (P) is needed in the soil for the purpose of fixing Nitrogen. This is the basis on which phosphorus based fertilizers are added to legume crops. The desert and semi-arid soils in nature has very low level of P. The genus of *Prosopis* has adapted itself to this low level of P and still able to fix Nitrogen (N) and maintain a high leaf protein concentration of 20%. (Felker, 2009). Drake and Strekel(1955) found a special adaptation in the root system by which the plant is able to break and absorb a relatively insoluble Calcium-phosphorus complexes breaking the myth that only water soluble macro nutrients can be absorbed by the trees.

**Adaptation to low soil Nitrogen (N)**

Arid soils, that contain low water and thus have low heat capacities, have the highest soil temperatures and lowest soil N and C of the world’s ecosystems (Felker, 2009). This means that for trees to grow and fix both Nitrogen and carbon in such conditions special adaptations are needed. The tree’s capacity to fix Nitrogen is inverse of its size. The tree fixes more Nitrogen when small and as the tree grows and accumulates other form of nitrates under the canopy the trees internal fixing mechanism goes down (Felker, 2009). There is a negative correlation between tree size and its Nitrogen fixing capacity, which is unique and different.

**Adaptation to Salinity**

Salinity causes drastic growth reduction in most plants, particularly of the legumes. But it is seen that some sub species of Prosopis (*P. pallida, P. juliflora, P. tamarugo, and P. alba*) have rapid growth even in conditions of Salinity as high as 45 dS m$^{-1}$ (deciSiemens per metre) which is 20 times greater than what other plants can survive in (Felker, 2009). This feature of the genus is exploited by the species particularly *Juliflora* to invade large tracts of
Arid and semi Arid land mass. The rise of salinity is aggravated by rising sea levels particularly in the coastal zones. In the arid areas exploitative use of groundwater for irrigation is adding more salts to the top soil thereby increasing the salinity, in addition to the depletion of ground water table causing death of native species. These could be the factors which enhance and make the subspecies P.Juliflora invasive.

Wood Properties

While the world views Teak and Sagwan as quality wood for its properties and are being exploited in commercial forestry, it is fascinating how nature had endowed Prosopis with a wood quality better than many timber trees, while growing in ecologically unblessed zones.

Figure 1: Cited from (Felker, 2009)
Figure 2: Charcoal manufacturing from Prosopis juliflora in Rural India

The Figure 1 shows the comparative shrinkages of various kinds of wood used including some exotic timber varieties (Felker, 2009), the algarrobo being a *prosopis* species. The wood which has very low shrinkage values is said to contain low quantity of water which will mean that with time the wood, its shape will not deteriorate due to loss of water. Low amount of Water in the wood also ensures that it is highly resistant to pests as it is not very easy to bore. Low shrinkage values, and near equal radial and tangential shrinkages, are probably the best measure of wood stability. Wood stability is one of the most important characteristics in furniture manufacture. It will be surprising to see that *Prosopis* technically ranks first for suitability to furniture. *Prosopis* timber could provide the basis for substantial value-added livelihoods in arid lands that would indirectly contribute to increased food security, which is one of FAO’s major objectives. The fact that this species does not require much management; is resistant to changes in environment will ensure that the livelihood generated will be stable and sustainable for the community as long as there is no overuse. Even currently the wood of *P. Juliflora* is used by the community to manufacture charcoal and used as firewood, but these are very low level of value addition. The carbon footprint of Charcoal suggests use of charcoal as fuel source being unsustainable and very high. Figure 2 shows the method used in Rural India which is used for preparation of charcoal emitting gases, smoke and causing air pollution; hence the alternate commercial use of this tree will be needed to control the invasiveness with anthropological intervention.
While many of these common properties are adopted by both the species (P.cineraria and P.juliflora), in India both of these have different historical significance at the community level.

**Prosopis Cineraria**

*Prosopis cineraria*, a native species to the deserts of India and Pakistan, has been revered in ancient writings in Sanskrit (Mann and Saxena 1980). This species is omnipresent in farmers’ fields in the Thar Desert where the soil fertility is increased below its canopy; all of the leaves of the trees (up to 10 m tall) are annually harvested for livestock food, and the pods are consumed for human food. It holds an important place in the rural economy in the northwest region of Indian subcontinent. *Prosopis cineraria* (L.) Druce is a deep rooted, Nitrogen fixing, multipurpose tree endemic to the hot deserts of India. The tree is known locally as Jandi or Khejri (India), Jand (Pakistan), and Ghaf (Arabic) and Vanni (Tamil)(khatri,Rathore,Patil, 2010).

![Prosopis Cineraria](image)

**Figure 3 : Source** (khatri,Rathore,Patil, 2010)

P.Cineraria - Significance in Hindu temples

Most of the temples are associated with a Tree which is called the “Sthala Vriksha” or the tree of the land. In Sanskrit, “sthala” is “a holy spot”; and “vriksha” means a tree. The “Sthala Vriksha”, therefore is the tree considered sacred to a particular temple or holy spot. It refers both in a generic sense to the species, and can also specifically denote one particular tree. This species of tree then is considered worthy of worship (called Vanni...
Marram in Tamil) and is representative of the Divinity specific to that holy spot. P.Cineraria is considered as the Shatala vriksha of many Shiva and Murugan Temples in South India which shows the historical importance given to this species (Various Open sources on Web). A tree will have such reverence only when the same is seen by the community as giving ecological returns.

**Cineraria - Legendary reference**

The *Vanni* tree (Tamil Name for P. Cineraria) is intrinsically associated with the primal tattva “Fire”. The Mahabharata has an elaborate legend (in the Anusasana Parva) of how Agni, the God of Fire, took refuge in the “Aswattha” and “Sami” (Vanni) trees successively, when the Gods were searching for Him on a particular occasion. Ever thereafter, for all Vedic rituals and Yagnas, the sacrificial fire is lit by rubbing together two sticks of wood, one of which necessarily has to be from the Vanni (Sami) tree and the other from the Aswattha tree (Arvind, 2013). The Aswattha tree (*Ficus religiosa*) is well known to be the most sacred of trees, mentioned in the Bhagavad Gita, and associated with all the Great Gods. It is very common to see this tree being protected by the community even in a dense urban area. The Vanni tree however is considered to be specifically sacred to Agni, and the primary abode in Nature of the tattva “Fire”. And thus a lot of fire rituals will involve sticks of wood taken from the Vanni tree specifically. In the Mahabharata there is a reference legend associated with the Vanni tree as offering a safe haven, much as it did to Agni: the Pandavas in their last year of exile which was to be incognito, entrust their divine weapons into the sacred care of a Vanni tree, which holds them safely till they come back one year later. And thus, it seems, that Vanni trees everywhere have local tales spun around them as to how a particular Raja or local chieftain, buried his weapons or his treasure under a Vanni tree, during war or exile or in troubled times generally (Arvind, 2013). Such references to this tree shows that the same has been existing for time immemorial in the Indian continent.

**P.Cineraria - Therapeutic Use in community**

*Prosopis cineraria* flower is pounded, mixed with sugar and used during pregnancy as safeguard against miscarriage. The bark of the tree is dry, acrid, bitter with a sharp taste; cooling, anthelmintic; tonic, cures leprosy, dysentery, bronchitis, asthma, leucoderma, piles
and tremors of the muscles. Leaf paste of *P. cineraria* is applied on boils and blisters, including mouth ulcers in livestock and leaf infusion on open sores on the skin (Khatri, Rathore, Patil, 2010). It is called *Kalpa Plant* in Ayurveda and Siddha literature. The whole plant is used in the Indigenous System of Medicine as a folk remedy for various ailments like leprosy, dysentery, bronchitis, asthma, leucoderma, piles, muscular tremor and wandering of the mind. (Robertson S, Narayanan N, Deattu N, Ravi Nargis N R, 2010).

These significant medical benefits could be the factor making this tree being revered in the different parts of India.

**P. Cineraria – A Dying source**

The tree is vanishing from many parts of the India. The reason for its decline in Rajasthan could be due to declining water table and growth of parasite *Gonoderma luciderm*, but there is nothing conclusive so far as per Dr. R. S. Mertia (Ex- CAZRI, Jaisalmer), an authority on desert vegetation (Aarti Dhar; The Hindu; 6th Nov 14, 2014).

**P. Juliflora – Introduction**

Introduction of *Prosopis Juliflora* (a native of Central America) in India could be traced first in literature from Lt. Col. R.H. Bendome, Conservator of Forests of Northern circle (Madras) requesting the Secretary of Revenue Department of Madras to supply *Prosopis* seed in 1876 for planting in arid tracts of South India (Reddy, 1978). Seeds were received from Jamaica and sown in South India during 1877. In Northern India, *P. Juliflora* was introduced in the arid tracts of Rajasthan, owing to its rapid growth features and drought hardiness during 1877 (Muthana and Arora, 1983). Aerial seeding of this species to cover large areas was done at Marwar in Rajasthan during 1930s (Harsh *et al.* 1996). The species was declared as a “Royal tree” and the Government officially instructed planting and protection of the tree species during 1940 (Muthana and Arora, 1983).

The Most interesting aspect could be what made introduction of an exotic species for arid zones when there were indigenous species of same genus available and being revered? Another question could be that while *P. Juliflora* has proliferated widely in similar conditions, what made the native species not take up the same position under community protection?
While a clear answer may not be available with current information I will try to present some documented reasons which could be a lead.

Figure 4: *P. Juliflora* in the Wild

**Genetic character**

While all of the other *Prosopis* Species have genetic imprint of $2n = 28$; *P. Juliflora* has an imprint of $4n$ (Harris et al. 2003). It is not within my competence to comment on what these genetic changes could cause and more importantly what could have caused such a change of genetic adaptations. Exploring this could explain the difference of *P. Juliflora* exploding.

**P. Juliflora - Tolerance to High PH**

The tolerance to high levels of PH (salinity in soil of 9-10) leads to *Prosopis Juliflora* growing satisfactorily without amendments up to pH 9.0, but when the soil pH was 10.4 it was necessary to plant the trees in auger holes with amendments of 3 kg of gypsum and 8 kg of farmyard manure per hole (Singh 1996). While the study by Singh above is more oriented to usage of *P. Juliflora* for restoration of Arid areas lost to salinity, can this indicate that historically the salinity of the arid areas of Rajasthan and Tamil Nadu was continuously increasing and that prevented the proliferation of the native species whereas the *P. Juliflora* proliferated.

**Antibacterial properties**

The species of *P. Juliflora* which being poisonous (administering to a dog caused instant mortality by decrease in blood pressure) has a wide ranging antimicrobial property.
Antimicrobial activity of julifloricine, an alkaloid isolated from Prosopis Juliflora, was studied in vitro against 40 microorganisms which included 31 bacteria, two Candida species, five dermatophytic fungi and two viruses. Significant inhibitory effect was noted against Gram positive bacteria (khatri, Rathore, Patil, 2010). This property is not very conducive to Ecosystem as it does not allow thriving of multiple species of plants and animals and could be a reason for the tree killing Palm trees in vicinity of two meters (observed and reported by community during interaction with self in Gulf of Mannar area). This also prevents natural predators of this species. This is in addition to physical features like very sharp spine which is poisonous and infectious.

From Reverence to A botanical disaster

There are many scholarly works world over on the proliferation of the species at many places across of the globe particularly in India and African continent. Not only the rural ecosystem but also a urban city like Delhi being affected by this species is evident from the report “Silent Botanical Disaster Engulfing India” in the Times of India, 25th May 2005, talking about removal of this species from land area of Delhi to improve the water table. The report in TOI, Madurai Dated 20th Oct. 2013 details the plan to remove “Seemai Karuvelam”( Tamil name for P.Juliflora) to improve the water table. The species brought in to India to contain aridity has engulfed uncontrolled large land masses even while some rural communities have adapted to living with it for its use as fuel-wood; Charcoal and fencing requirements.

After this brief study, the interest on questioning evolution of such contrasting species has increased; Is it a planned mutation by nature? or nature’s way of attaining an equilibrium resilient status with increased anthropological interference, which humans can only adapt to live with?

References

http://bhagavan-sri-ramana-maharshi.blogspot.in/2013/06/interesting-but-forgotten-places-iv.html


