Plectranthus vettiveroides – a least known vetiver on the verge of extinction

Man was a foraging hunter–gatherer during the initial period of evolution. Later he started cultivating cereals and legumes and thus the transition from foraging to farming occurred. As a result, many of the useful wild plants have come under cultivation. Today, thousands of plant species are cultivated throughout the world for various uses. For most of those cultivated species, the wild populations exist in their natural habitats. However, there are some economically significant plants which are extinct in the wild, but survive only under cultivation due to their economical value. *Plectranthus vettiveroides* (Jacob) N.P. Singh & B.D. Sharma (syn. *Coleus vettiveroides* Jacob) belonging to the family Lamiaceae, is one such species which has so far not been reported in wild habitats, but exists only under cultivation.

P. vettiveroides, known as *Hrivera* (in Sanskrit), *Iribeli* (in Malayalam), *Kuruver* and *Vetiver* (in Tamil), has long been used in both Ayurveda and Siddha. The species was first described and illustrated as *Iribeli* in 1689 by Hendrik Adriaan Van Rheede in his monumental work on the *Hortus Malabaricus*[1]. Later, Elliot[2] has mentioned the species as *Coleus osmirrhizou* Elliot in his *Flora Andhirica*. But a scrutiny of the literature on *C. osmirrhizou* has revealed that it is an unresolved name (http://www.theplantlist.org/tpl/record/kew-46043, accessed on 8 September 2014). It is also considered as a manuscript name[3]. Therefore, no detailed taxonomic information is available on this name, except a herbarium specimen in the Madras Herbarium (MH), Botanical Survey of India, Coimbatore (No. 40797). This specimen was collected by Abboy Naidu from a cultivation field in Mahabalipuram, Kanchipuram district, Tamil Nadu on 25 May 1879 and named *Coleus osmirrhizou* Elliot and *Kuru veru* in Tamil. Afterwards, it was scientifically described with a valid nomenclature by Cherian Jacob in 1942 as *Coleus vettiveroides*[3]. Later, the species was transferred to the genus *Plectranthus*[4]. Further information on this species is lacking in *Floras and Herbaria*. Interestingly, all the above-mentioned reports and specimens describe and illustrate *P. vettiveroides* in vegetative condition.

There is a dispute in the botanical identity of the name *Iribeli* and *Hrivera*. The name *Iribeli* has been equated with *Plectranthus amboinicus* (Lour.) Spreng. (syn.: *Coleus amboinicus* Lour.)[1] and *Plectranthus hadiensis* (Forssk.) Schweinf. ex Spreng. (syn.: *P. zeylanicus* Benth.; *C. zeylanicus* (Benth.) Cramer)[5]. Rheede has mentioned two types of *Iribeli*, namely black and white. The white *Iribeli* or *Ramacciam* (in Malayalam) refers to the aromatic grass *Vetiveria zizanioides* (L.) Nash., whereas the clear description and illustration of black *Iribeli* distinctly refers to *P. vettiveroides*. The root of Rheede's black *Iribeli* is ash-obscure coloured and strongly aromatic. The roots of *P. vettiveroides* are straw-coloured when fresh and turn black and are strongly aromatic on drying (Figure 1 *d* and *e*). But the roots of *P. amboinicus* and *P. hadiensis* neither turn black nor are aromatic on drying. Other important distinguishing characters of *Iribeli* are the length of the leaf petiole and fragrance of the leaf. Rheede has described and illustrated *Iribeli* with long petiole and never described that the leaf is aromatic. The leaf of *P. vettiveroides* is not aromatic and the petiole is very long (up to 10 cm long). But in *P. amboinicus* and *P. hadiensis*, the leaves are aromatic and the petioles are short (less than 4 cm). Sivarajan and Balachandran[5] providing an illustration and description of *P. hadiensis* and also quoting Rheede's illustration, have identified *Hrivera* as *P. hadiensis*. But these two illustrations show a mismatch. Some authors have equated the Sanskrit name *Hrivera* correctly to *P. vettiveroides*, but mentioned the species as native to Sri Lanka[6,7]. This species has so far not been reported from Sri Lanka and is also not described in the *Flora of Ceylon*[8]. However, in the *Flora of Ceylon*, *P. hadiensis* is named as *Iriweriya*[8]. The photographs of *P. amboinicus*, *P. hadiensis* and *P. vettiveroides* are provided (Figure 1 *a*–*c*) in order to distinguish and clearly identify them.

Earlier, in many parts of Tamil Nadu, especially in the regions where it was cultivated, the plant has been called *Vetiver* and *Kuruver*. The dried root of *P. vettiveroides* has been traditionally used to prepare Vetiver garland to decorate deities in many temples in Tamil Nadu[3]. The Telugu people who visited the temples in Tamil Nadu might have thought the Vetiver roots (of *P. vettiveroides*) to be those of 'khus-khus', which refers to the aromatic grass *V. zizanioides*. Later, the name Vetiver might have been unknowing applied to *V. zizanioides* by the Telugu people and introduced to botanical works through the botanists of the East India Company, whose botanical studies were centred at Samalkot in Andhra Pradesh[3]. Though *V. zizanioides* has been used for many centuries, only in the beginning of 17th century it was known as Vetiver[3,9]. Prior to that, the grass was known as *Velamichai ver* in Tamil. Therefore, it is believed that the name Vetiver is derived from Tamil and originally applicable to *P. vettiveroides*[3]. Another vernacular name of *P. vettiveroides*, *Kuruver*, might have been derived from the word *Karu Ver* – *Karu* means black and *Ver* means root in Tamil, as the dried root of the species appears black in colour. Even today, some Siddha doctors refer to *P. vettiveroides* as Vetiver and *V. zizanioides* as *Velamichai ver* or *Ramacham*. In Telugu, *P. vettiveroides* is called *Kuriveru* and *Vettiveru*[10].

P. vettiveroides is a sub-succulent, minutely pubescent herb growing up to 2 feet high. The roots are copiously fibrous, up to 50 cm long, slender, thin and easily cut off. They are straw-coloured and slightly fragrant when fresh, but turn dark and are strongly aromatic when dry. The stems are four-angled, succulent; green and/or brown, minutely pubescent. The leaves are sub-succulent, opposite, orbicular to ovate, up to 10 × 12 cm, base and apex rounded, margin toothed, minutely pubescent on both sides; petiole up to 12 cm long. The flowers and fruits have so far not been described and flowering has also not been seen by the farmers who traditionally cultivate this species for more than a century. Perhaps, the plant might be harvested well before its flowering stage for its fast-growing fragrance roots, as informed by the farmers that roots are harvested after 4 months from planting.

Figure 1. ***a***, *Plectranthus amboinicus*; ***b***, *Plectranthus hadiensis*; ***c***, *Plectranthus vettiveroides*; ***d***, Fresh root of *P. vettiveroides*; ***e***, Dry root of *P. vettiveroides*.

Even the plant growing in the garden of The Institute of Trans-Disciplinary Health Sciences & Technology (formerly FRLHT), Bengaluru has never flowered in the last 10 years. However, Rheede has mentioned that the flowers appear on spike inflorescence when the plant becomes older[1]. But the flowers have not been described. The plant has been propagated through stem cuttings.

The fibrous and strongly aromatic root of *P. vettiveroides* has economical and religious significance. The roots are used in various formulations in Ayurveda and Siddha[7]. The roots and root oil are traditionally used in anti-cachetic, fever, burning of liver, swelling of hands and feet, head-ache, dysentery and eye pain[1]. The roots are also used for the treatment of burning eyes, diarrhoea, intrinsic haemorrhage, strangury, hyperdipsia, leprosy, leucoderma ulcer, vomiting, skin diseases, giddiness and quenching thirst. It is also used to promote hair growth[10]. The extract of *Hrivera* (*P. vettiveroides*), which has anti-bacterial, deodorant and cooling properties, is used as one of the ingredients in hand sanitizer[11]. In Ayurveda, *P. vettiveroides* is traditionally used for vomiting and nausea[12,13]. The plant is used in some ayurvedic preparations like *iruveli kashayam*, *devashtagandha* and *snana choornam*[14]. The dried roots are traditionally used to prepare vetiver garland as mentioned earlier[3]. The dried black stem is sold as vetiver in raw drug shops in Tamil Nadu and is one of the herbal materials used in *Yagya*. The dried stem powder is prescribed by Siddha doctors as bathing powder. The dried stem is also used in incense industry as an ingredient.

Thorough review of the literature revealed that *P. vettiveroides* is probably native and endemic to Kerala and Tamil Nadu[1,3,15]. However, the wild source of this species is still not known. Even Rheede, who first described and illustrated the species, had reported that it was cultivated as a medicinal plant in the erstwhile Rapolim Kingdom, presently Edappalli[1]. All earlier reports and collections of this species were from cultivated sources[2,3,10]. It is believed that the natural habitat of this species might be Sirkazhi region of Nagapattinam district, Tamil Nadu[3]. At the beginning of the 20th century, *P. vettiveroides* was under large-scale cultivation in the erstwhile North Arcot, Coimbatore, Madurai, Thanjavur, Tirunelveli and Chengalpet districts of Tamil Nadu, and Palakkad district of Kerala[3,10,16]. Since the species is not recorded from natural habitats, it has been assessed and considered as possibly extinct in the wild[10]. The field surveys in the known regions of its cultivation reveal that *P. vettiveroides* is currently cultivated in a small pocket of sandy loam soil in Thillaimangalam village near Kollidam in Sirkazhi Taluk, Nagapattinam district and in Sundarapperumal Koil village in Thanjavur district, Tamil Nadu. The farmers informed that a decade ago more than 30 farmers in and around Kollidam and about 20 farmers in Sundaraperumal koil had cultivated the plant for its fragrant roots and sold to different markets, including the Chennai market. But now the number of farmers cultivating the plant has drastically reduced to less than 10. Apart from these two places, the germplasm is expected to be present in Jawaharlal Nehru Tropical

Botanic Garden and Research Institute (JNTBGRI), Thiruvananthapuram, where research work has been undertaken on this species[16,17]. Therefore, the minimum number of germplasm under cultivation poses a great threat to the species. The farmers who are currently cultivating the species are aged and may give up the cultivation anytime. The younger generation of farmers are not interested in cultivating this species in the two regions. Realizing the economic and conservation significance of the species, the National Medicinal Plants Board (NMPB), Government of India, has identified and prioritized the species as one of the 32 medicinal plant species for its overall development and conservation under promotional and commercial scheme. The efforts of JNTBGRI in developing agrotechnology package for this species are noteworthy[16,17]. However, new techniques need to be developed to ease the cultivation and harvesting of the delicate, thin fibrous roots. The potentiality of the root of the species also needs to be scientifically evaluated for commercial utilization, which will encourage more farmers to take up the cultivation and thus, the species will be conserved. Despite the efforts of NMPB and other agencies, the species is still under peril. Therefore, further conservation efforts and promotion of its cultivation are urgently needed to save the species from extinction.

1. Manilal, K. S., *Van Rheede's Hortus Malabaricus (English edn) with Annotations and Modern Botanical Nomenclature*, University of Kerala, Thiruvananthapuram, 2003, vol. 9, pp. 249–251.
2. Elliot, W., *Flora Andhirica – A Vernacular and Botanical List of Plants Commonly Met with in the Telegu Districts of the Northern Circars*, Graves & Co, Madras, 1859.
3. Jacob, K. C., *J. Bombay Nat. Hist. Soc*., 1942, **42**, 320–322.
4. Singh, N. P. and Sharma, B. D., *J. Bombay Nat. Hist. Soc*., 1982, **79**, 712.
5. Sivarajan, V. V. and Balachandran, I., *Hribera* and *Amragandha*. *Ancient Sci. Life*, 1986, **5**(4), 250–254.
6. Khare, C. P., *Indian Medicinal Plants: An Illustrated Dictionary*, Springer-Verlag, Berlin, 2007, p. 167.
7. Saraswathy, A., Amala, A. and Devi, A., *Indian J. Traditional Knowledge*, 2011, **10**(4), 636–642.
8. Cramer, L. H., In *A Revised Handbook to the Flora of Ceylon, Vol. 3* (eds Dassanayake, M. D. and Fosberg, F. R.), Oxford & IHB Publishing Co, New Delhi, 1981.
9. Maffei, M. (ed.), In *Vetiveria, the Genus Vetiveria*, Taylor & Francis, London, 2002.
10. Ravikumar, K. and Ved, D. K., *Illustrated Field Guide – 100 Red Listed Medicinal Plants of Conservation Concern in Southern India*, FRLHT, Bengaluru, 2000, pp. 301–304.
11. Mondal, S. and Kolhapure, S. A., *Antiseptic*, 2004, **101**(2), 55–57.
12. Dash, V. B. and Kashyup, V. L., *Materia Medica of Ayurveda based on Ayurveda Saukhyan of Todarananda*, Concept Publishing Company, New Delhi, 1987, p. 711.
13. Waldia, S., Bipin, C. J., Uma, P. and Mukesh, C. J., *Chem. Biodivers.*, 2011, **8**, 244–252.
14. Soni, H. and Singhai, A. K., *Asian J. Pharm. Clin. Res*., 2012, **5**(1), 12–17.
15. Ahmedullah, M. and Nayar, M. P., In *Flora of India, Series IV, Vol. 1, Endemic Plants of the Indian Region, Penisular India*, Botanical Survey of India, Kolkata, 1986, p. 135.
16. Safeer, P. M., Sreekumar, S., Krishnan, P. N., Biju, C. K. and Seeja, G., *IOSR J. Agric. Vet. Sci*., 2013, **6**(3), 47–53.
17. Safeer, P. M., Sreekumar, S., Krishnan, P. N., Biju, C. K. and Seeja, G., *IOSR J. Agric. Vet. Sci*., 2013, **5**(3), 41–45.

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Possibility of using isotopic composition of ground-level vapour for monitoring arrival and withdrawl of southwest monsoon

Stable isotopes of oxygen and hydrogen have long been used to trace the hydrological processes[1] on the principle that the lighter isotopes of water (e.g. H_2O) preferentially evaporate over its heavier isotopes (e.g. HDO or $H_2{}^{18}O$), and the heavier isotopes preferentially condense[2]. In this line, several studies[3–5] were carried out all over the world to characterize the local meteoric lines for generalizing the amalgamation of various hydrological processes taking place over multiple temporal and spatial scales. These studies may be able to provide us the precise analysis of a synoptic event due to the dependence on many physical and atmospheric processes[6]. Isotopic composition of moisture depends upon many processes like transportation, condensation, precipitation and re-evaporation of moisture. The composition of the vapour-plus-condensed water additionally depends on microphysical processes that determine the fraction of condensed water that is converted to precipitation. The isotopic composition of the precipitation at any vertical level depends on the composition of the water falling from above on the fraction of the precipitation that is re-evaporated in unsaturated air, and on isotopic exchanges that take place between the falling drops and the vapour surrounding them. The influence of convection on the water isotopic composition therefore depends on a combination of physical, microphysical and turbulent processes occurring within the clouds. Many modelling studies like general circulation model (GCM), Lagrangian