

Commercialization – a suggested approach for conserving a threatened fern, *Pteris tricolor* Linden

A globally threatened and variegated fern, *Pteris tricolor* Linden, is listed under different threat categories of the International Union for Conservation of Nature and Natural Resources (IUCN)¹. It has a restricted distribution in far North East India, Myanmar and Yunnan province of China^{2,3}. Its discovery, however, was accidental; Linden⁴ found this species growing spontaneously in the Malaccan orchid consignment at his nursery in Bruxelles (Brussels), Belgium, and described it as a new species with accurate, spectacularly coloured illustration (also reproduced by Fraser-Jenkins⁵). Its Malaccan origin^{4,6-9} is rejected because till date it has not been reported from there. Later, it was postulated that it has more likely come from Myanmar¹⁰, or alternatively from China or NE India; but in all three countries it is a rare species.

As the name indicates, *P. tricolor* has three attractive colours (bright green lamina segments with white, silvery segment bases and a dark red stripe along the pinna-costa and pinnule midribs; Figure 1), but young fronds are pinkish-red throughout apart from a paler central stripe along each pinna. Owing to the distinctive and colourful fronds, it was under cultivation in European gardens, fern houses and nurseries since its discovery and won several prizes during exhibitions. During the 19th century, it was an expensive and prized plant, listed occasionally in nursery catalogues and various notes in *The Gardeners' Chronicle and Agricultural Gazette*^{6,7}. Unfortunately, owing to compulsory use of land for crops, after the First World War, followed by food shortage due to the Second World War, this fern vanished from European gardens^{10,11}, though it still survives as a rarity in North American nurseries and gardens^{10,12}, even though many listings of *P. tricolor* actually refer to *Pteris normalis* and other slightly less coloured species, and only seldom to the true species.

Taxonomically, *P. tricolor* is allied to *Pteris normalis* D. Don and *Pteris aspericaulis* Wall. ex. J. Agardh, and has sometimes been wrongly treated as a synonym or variety of *Pteris aspericaulis*^{8,11,13}. Apart from its colouration, the species differs from the related species

P. aspericaulis or *Pteris quadriaurita* Retz. in having smooth glossy stipes, fewer pinnae, non-apiculate segment apices and abundant dark red setae above the ultimate segment midribs. Its cytotype remains unknown. Due to the presence of variegated or young pink fronds, *P. tricolor* has often been confused, especially in cultivation, with other variegated species (*Pteris argyrea* T. Moore, *Pteris subquinata* Wall. ex. J. Agardh, *Pteris blumeana* J. Agardh, etc.) or pink young-fronded species of *Pteris* (*P. normalis*, *P. aspericaulis* and *P. roseolilacina* Hieron.)^{2,8,9,14}. Hieronymus⁹ erroneously cited Jerdon's collection of a white, variegated *P. subquinata* from Sikkim; hence most of the Indian reports¹⁵⁻¹⁷ (except Fraser-Jenkins^{2,5,10}) of this species are either wrong or ambiguous. Further, a recent new state record of *P. tricolor* from Mizoram¹⁸ is also incorrect due to not consulting the Mizoram collections (*N.E. Parry* 23, Lushai Hills, 30 July 1924 CAL; *W.N. Koelz* 27785, Mizoram, Aijal, Lushai Hills, 3500 ft., 30.3.1951, MICH) and the literature¹⁷.

In India, *P. tricolor* has been reported from Manipur and Mizoram². Recently, it has been collected from Meghalaya for the first time in the East Khasi Hills by one of us (S.S.). It usually grows in shady to semi-shaded places of moist deciduous and semi-evergreen forests at 600–1500 m elevation, in association with *Selaginella decipiens* Warb., *Dryopteris sparsa* (D. Don) Kunze, *Thelypteris clarkei* C. F. Reed, *Polystichum lentum* (D. Don) T. Moore, *Asplenium cheilosorum*, Kunze ex. Mett., etc. We also observed that the plant requires semi-shaded or diffused sunlight to retain its variegated colours and the fronds turn green when exposed to bright sunlight.

P. tricolor has been listed for India under two different IUCN categories – endangered (EN)¹ and near threatened (NT)¹⁹, of which NT was a preliminary placement, superseded by EN. Therefore, known populations of this high-conservation priority fern in NE India have been reassessed using IUCN criteria²⁰. During our exploration (from 2012 to 2016), we found 24, 42 and 26 individuals growing in Mizoram, Meghalaya and

Manipur respectively. In Meghalaya, the species is found only in Pynursla area of East Khasi Hills. Manipur hosts a single locality in Imphal–Tamenglong, along the roadside. On the other hand, in Mizoram, it is found in three locations (two in Murlen National Park and one in Tawi Wildlife Sanctuary). The Mizoram localities are situated within Protected Areas (PAs); however, the Manipur and Meghalaya localities are in a human activity zone or in disturbed habitat, and are hence potentially prone to extinction due to one or more anthropogenic factors.

In the present study we found the area of occupancy (AOO, Criterion B2) to be 40 km² and the species was found growing in only five locations (Criterion B2a). We have continuously observed grazing in Murlen and Tamenglong forests, and high anthropogenic pressure along the trails in Manipur and Meghalaya has caused deterioration in the quality of the habitats (Criterion B2b iii). The number of mature individuals reported was <250 (Criterion D). Although the extent of occurrence (EOO) of the species in India is 9317.2 km² (Figure 2), it is not possible to apply Criteria A, C and E due to lack of data on reduction in population size and estimates of decline. According to IUCN guidelines²⁰, the taxon qualifies for the 'Endangered' category [EN, B2a, B2b (iii), D] in India. We could not assess the threat status of *P. tricolor* at the global level due to lack of sufficient data on Chinese and Myanmar populations, but based on the vast knowledge and experience, the status in India given by Fraser-Jenkins¹ is correct. However, Fraser-Jenkins (pers. commun.) has informed us that the species is very rare in both Myanmar and China, and is thus globally threatened.

P. tricolor is both a threatened and high-conservation-priority species, and, importantly, a species of high horticultural value and economic potential. During the 1860s, it was sold at 6–15 shillings per plant in the European markets^{4,6,7}. The present-day cost would be Rs 1500–3500. Although the plant is considered difficult to cultivate^{2,10}, we have found evidence from the literature that it was widely cultivated in various nurseries and fern houses in Europe



Figure 1. *Pteris tricolor* habit; (inset) close-up of pinnae.

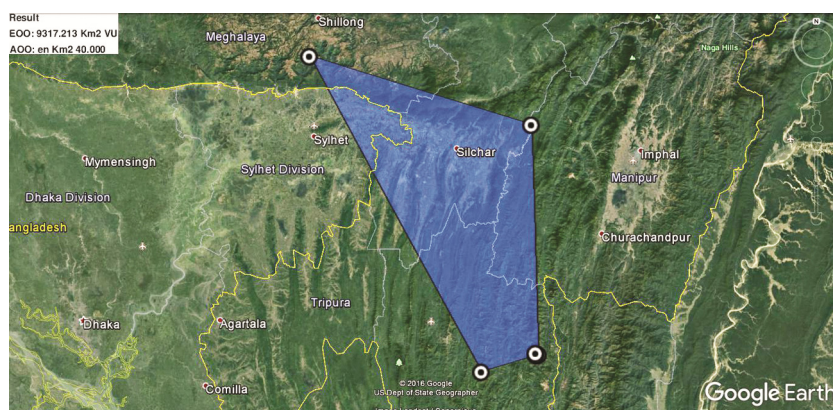


Figure 2. *P. tricolor* distribution map in India showing AOO & EOO.



Figure 3. *P. tricolor* cultivation at Botanical Survey of India, Dehradun.

before the Second World War. We have also cultivated this plant successfully in the botanical garden of the Botanical Survey of India (BSI), Northern Regional Centre, Dehradun, after vegetative multiplication (Figure 3).

In India, 30% of the known individuals of this endangered fern grow inside PAs and the rest face threat of extinction. Due to the low number of localities (5), limited number of individuals (<100) and habitat fragmentation (the biggest threat

in the present scenario), *P. tricolor* is one of the topmost species for priority of conservation in India. Furthermore, this species is not under cultivation in India and has already vanished from Europe^{10,11}, even though it is maintained in a few nurseries in USA¹⁰, such as Henry's Plant Farm¹² which has the correct species under cultivation. Therefore both *in situ* and *ex situ* conservation are urgently required for its conservation and sustainable use. For *in situ* conservation, Pynursla block of East Khasi Hills and Tamenglong forest of Manipur should be declared as conservation sites or PAs, and uprooting of the wild population should be strictly banned. However, for *ex situ* conservation, the species can be introduced in botanic gardens and Forest Department nurseries by spore germination or vegetative propagation, and after successful propagation it can be introduced commercially into the nursery trade. For mass multiplication of this species, tissue culture practice can also be adopted. The introduction of this species into horticulture will promote its conservation along with revenue generation.

We informally refer to this species as 'the tricoloured brake fern', but for horticultural purposes a formal cultivar name in English is required. Thus, here we name the variegated form of the fern as *Pteris tricolor* cv. 'Tricolour' (Kholia & Sachin Sharma). It is similar to the European *Polypodium cambricum* L. cv. 'Cambrian' (Fraser-Jenkins), where the species was first described from a special form, which required a cultivar name in order to distinguish it from the 'normal' plant. Similarly, the white variegated East Himalayan *Pteris subquinata* (common name: Sikkim silver brake fern²¹) has been named as cv. 'White Hooker' (Fraser-Jenkins)²². The exact GPS locations and pinpoint localities have not been mentioned here in order to avoid exploitation of wild populations of this fern by plant hunters and growers, but the concerned Biodiversity Boards and Forest Departments will be informed in order for them to take necessary action to ensure its conservation.

1. Fraser-Jenkins, C. R., *Bull. Natl. Mus. Nat. Sci. Tokyo, Ser. B*, 2012, **38**(4), 167.
2. Fraser-Jenkins, C. R., Gandhi, K. N., Kholia, B. S. and Benniamin, A., *An Annotated Checklist of Indian Pteridophytes*,

- Part-I (Lycopodiaceae to Thelypteridaceae)*, Bishen Singh Mahendra Pal Singh, Dehradun, 2016.
- Jiao, Y. and Li, C.-S., *Yunnan Ferns of China*, Science Press, Beijing, China, 2001, p. 40.
 - Linden, J., *Hortus Lindenianus. Jardin Royal de zoologie et d'horticulture*, Bruxelles, 1859.
 - Fraser-Jenkins, C. R., *The First Botanical Collectors in Nepal, The Fern Collections of Hamilton, Gardner and Wallich – Lost Herbaria, a Lost Botanist, Lost Letters and Lost Books, Somewhat Rediscovered*, Bishen Singh Mahendra Pal Singh, Dehradun, 2006.
 - Moore, T., *Gard. Chronicle Agric. Gaz.*, 1860, **10**(3), 217.
 - Linden, J., *Gard. Chronicle Agric. Gaz.*, 1860, **11**(2), 123.
 - Lowe, E. J., *A Natural History of New and Rare Ferns*, Groombridge and Sons, London, UK, 1864.
 - Hieronymus, G., *Hedwigia*, 1914, **55**, 325–375.
 - Fraser-Jenkins, C. R., *Taxonomic Revision of Three Hundred Indian Subcontinental Pteridophytes with a Revised Census – List*, Bishen Singh Mahendra Pal Singh, Dehradun, 2008.
 - Walker, T. G., *Br. Fern Gaz.*, 1970, **10**(3), 143–151.
 - Olsen, S., *Encyclopaedia of Garden Ferns*, Timber Press, Inc, Portland, Oregon, USA, 2007.
 - Schneider, G., *The Book of Choice Ferns, for Garden, Conservatory and Stove, Vol. III*, London, UK, 1894.
 - Herincq, F., *J. Des Amateurs et Des Interet Horticoles*, 1861, **3**, 56–57.
 - Dixit, R. D., *A Census of the Indian Pteridophytes*, Botanical Survey of India, Howrah, 1984.
 - Chandra, S., *The Ferns of India (Enumeration, Synonyms and Distribution)*, International Book Distributors, Dehradun, 2000.
 - Ghosh, S. R., Ghosh, B., Biswas, A. and Ghosh, R. K., *The Pteridophytic Flora of Eastern India, Flora of India, Series 4*, Botanical Survey of India, Kolkata, 2004, vol. 1, pp. 1–591.
 - Lallawmkimi and Lalramnghinglova, H., In *Special Habitats and Threatened Plants of India* (ed. Rawat, G. S.), ENVIS Wildlife and Protected Areas, 2008, p. 91.
 - Chandra, S., Fraser-Jenkins, C. R., Kumari, A. and Srivastava, A., *Taiwania*, 2008, **53**(2), 170–209.
 - IUCN, *Guidelines for Application of IUCN Red List Criteria at Regional and National Levels: Version 4.0*, IUCN, Gland, Switzerland, 2012.
 - Kholia, B. S., *Curr. Sci.*, 2010, **99**(8), 999.
 - Fraser-Jenkins, C. R., Kandel, D. R. and Pariyar, S., *Ferns and Fern-Allies of Nepal – I*, National Herbarium and Plant Laboratories, Department of Plant Resources, Ministry of Forests and Soil Conservation, Kathmandu, Nepal, 2015.

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Accelerating regeneration of threatened wild banana (*Musa paramjitiana* L.J. Singh) endemic to Andaman and Nicobar Islands, India

Andaman and Nicobar (A&N) Islands in the Bay of Bengal are known to harbour 2426 species of angiosperms, of which about 300 are endemic to these islands¹. This diversity includes taxa of ecological and economic importance. The wealth of horticulturally useful species, including their wild relatives present in these Islands has been documented². However, new species having potential agricultural importance are being discovered and reported regularly as large areas of these islands are yet to be explored systematically³. Recently, a new endemic species of seeded wild banana, viz. *Musa paramjitiana* L.J. Singh has been reported from the Andaman Islands³, with observations on multiplication of species under field conditions. However, the threats posed

by human interventions and damage by elephants have led to restricted distribution of the species in Andaman Islands and its categorization as ‘Critically Endangered’ species³. Under such conditions, assisted regeneration of species by raising nursery would be advantageous. Here, we studied the effect of seed treatments and substrates on germination and seedling growth parameters in the species for facilitating its conservation and further use in research.

Fully mature fruits of *M. paramjitiana* were collected from Dhanikhari Experimental Garden cum Arboretum of Botanical Survey of India, Andaman and Nicobar Regional Centre, Port Blair, and were allowed to ripe naturally. Seeds were extracted from fruits, pulp was

washed and seeds were soaked overnight in fungicide (carbendazim, 0.1%) as prophylactic measure before undergoing any treatment. Seeds were divided into different groups and subjected to the following treatments. T₁: untreated control; T₂: water soaking (24 h); T₃: gibberellic acid (GA₃) (500 mg/l, 24 h); T₄: KNO₃ (0.1%, 24 h); T₅: mechanical scarification + water soaking (24 h); T₆: mechanical scarification + GA₃ (500 mg/l, 24 h) and T₇: mechanical scarification + KNO₃ (0.1%, 24 h). Scarification was done by carefully removing a small portion of seed coat using sharp scissors. Seeds were sown in pro-trays filled with coir pith. The experiment was laid in completely randomized design with three replications of 20 seeds each.