Population structure and conservation of endangered *Citrus indica* Yu.Tanaka (Rutaceae) in Behali Reserve Forest of Assam, India

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Abstract

The occurrence of endangered plant, *Citrus indica* Yu.Tanaka (Rutaceae) was recorded from the Behali Reserve Forest in Assam, India. Its distribution pattern, association and status in North-east India, prospect and possible methods of proper conservation has been discussed in the article.

Key words: *Citrus indica*, Behali Reserve Forest, Status, Conservation

INTRODUCTION

The genus *Citrus* L. (Rutaceae) and its related genera *Eremocitrus* Swingle, *Fortunella* Swingle, *Microcitrus* Swingle and *Poncirus* Raf. are belonging to subfamily Aurantioideae and are widely scattered across the monsoonal regions from west Pakistan to North-central China and south through the East Indian Archipelago to New Guinea and the Bismarck Archipelago, Northeastern Australia, New Caledonia, Melanesia and the western Polynesian islands (Swingle & Reece 1967). East Asia comprising Northeast India (earlier Assam), northern Myanmar and western Yunnan in the foothills of the Himalayas is considered to be one of the centres of origin of *Citrus* species. During the late Miocene, a sudden speciation event have led to the diversification of branches of the ancestral *Citrus* species, and this radiation has enabled the shift of the genus into drier regions from the wet monsoon climate (Wu *et al.* 2018).

Recent studies by Sharma *et al.* (2004), Malik *et al.* (2006) and Hazarika (2012) on genetic resources of *Citrus* in Northeastern India indicated the presence of 23 species, 1 subspecies and 68 varieties, and hence this area still attains a special status as a treasure house of *Citrus* germplasm. Seven species of *Citrus* are still growing in wild and semi-wild conditions in small pockets of the Northeast Indian region as *Citrus indica* Yu.Tanaka, *C. hystrix* DC. (= *C. macroptera* Montrouz.), *C. latipes* (Swingle) Yu.Tanaka, *C. megaloxycarpa* Lush., *C. medica* L., *Citrus cavaleriei* H.Lév. ex Cavalerie (= *C. ichangensis* Swingle) and *C. assamensis* R.M.Dutta & Bhattacharya and listed as endangered by threat perception analysis as per IUCN norms (Singh & Singh 2003; Malik *et al.* 2006).

Citrus indica 'Indian wild orange' recognized by Tanaka in 1928, is believed to be the most primitive of all the *Citrus* species and the progenitor of the cultivated ones (Singh 1981). Tanaka (1937) stated 'It is really a wild citrus found in Nowgong (Nagaon) district,

Khasi hills and Manipur in Assam'. According to Singh (1981), the plant is endemic to Northeastern Himalayas and reported to be occurring wild in Naga Hills of Nagaland, Garo Hills of Meghalaya and Kaziranga Reserve Forest in Assam. But, the recent surveys reported its presence only in Tura range of Garo Hills of Meghalaya (Upadhyay & Sundriyal 1998; Singh & Singh 2003; Malik *et al.* 2006). The species is somewhat cultivated in Garo Hills as the fruits are used medicinally and also a fruit is kept on the dead body before cremation to keep away the from affecting the relatives (Malik *et al.* 2006).

Behali Reserve Forest:

Behali Reserve Forest (BRF) is situated in the Biswanath District of the state of Assam, India, bordering the state of Arunachal Pradesh, and with central coordinates 26° 54' 32" N and 93° 18' 29" E and the altitude varies from 80 – 100 m amsl. The area of the BRF is 14016 ha and the vegetation type is mainly forested, evergreen and semi-evergreen types. However, Kushwaha and Hazarika (2004) with their Remote Sensing mapping treated these forests as moist deciduous and degraded. About 3,375, ha area of BRF is encroached by various groups of people namely Nepali, Karbi, Bodo and Tea-tribes. However, even today, some areas of the reserve is still covered with good natural vegetation (Bora 2001).

Present survey:

During the ongoing floristic and phytosociological surveys of Behali Reserve Forest (BRF) a patch of *Citrus indica* was encountered in a moist tract of primary forest. The patch covers only 20 m² area and there are seven plants, of which three are with only flowers, two with fruits and flower-buds, one sapling and one old plant of which the main stem was cut-off and new shoots (coppices) are coming out from base. To record the presence of any other population within the BRF, an additional 10 km² area were surveyed and the information collected from forest-dependent people of the nearby villages were analysed but no more plant was detected.

Another wild species, *Citrus medica* is known to have distribution all over the country (Singh & Chadha 1993) in warmer regions. This species is also found in BRF. Vavilov (1950) have noticed the occurrence of Citron (*C. medica*) in wild, as well as in cultivation during his visit to North-east India. It has also a good distribution in the BRF, but restricted towards south in deciduous open scrubs, or along the river-banks, whereas, *C. indica* is restricted only in the northern part of the forest at the geographical location 26° 53' 25" N latitude and 93° 15' 80" E longitude.

Taxonomic treatment:

Citrus indica Yu. Tanaka, Stud. Citrol. 2: 164. 1929; Fl. India 4: 281 – 282.

Local name: 'Memang Narang' [= Ghost orange in Garo language (Singh 1981)]

Shrubs to 3 m high; branchlets terete, glabrous, dark green, turns brownish with age, spreading; thorns short, upto 1 cm long, dark green with brown tip. Leaves unifoliate; petioles 1.5 – 2.0 cm long, slightly winged, articulated at apex; lamina oblong-lanceolate to elliptic-oblong, 6.5 – 11.0 × 2.5 – 5.0 cm, sub-entire to shallowly crenate, shortly caudate-obtuse, base attenuate and finally rounded, 2° veins 5 – 7 pairs, prominent abaxially, oblique, alternate. Flowers solitary, rarely in pairs, axillary; pedicels c. 4 mm long, glabrous, greenish white; flowers male and bisexual, monoecious; calyx cupular with 4 – 5 minute lobes, deltoid, conspicuously pellucid-punctate abaxially; petals 5, oblong, 10 – 18 × 2 – 6 mm, obtuse, glandular, white with yellowish tinge; stamens 22 – 25, in three whorls, innermost whorl shortest; filaments united one third of the length, free above, glabrous, white; anthers 1 – 3 mm long, introrse; ovary vase

PLATE - I. *Citrus indica* Yu.Tanaka (Rutaceae): **A.** Whole Plant; **B.** A flowering twig; **C.** Lamina adaxial surface; **D.** Lamina abaxial surface; **E.** Flower in side view; **F.** Flower in top view; **G & H.** Fruits in different views; **I.** Stamens; **J.** Style and stigma; **K.** Fruit sliced transversely through the middle; **L.** Seed. [Photos: Dipankar Borah]

shaped, 8 – 11 locular; style terete, white; stigma capitate. Fruits globose to obovoid, 4 – 5 cm across, depressed-obtuse at apex, base cuneate, smooth, glandular, deep orange to scarlet red when ripe, pericarp thin, slightly adherent; mesocarp thin, soft,

white; endocarp segments 8 – 11; juicy pulps yellowish white, fusiform or polygonal, stalked, shiny, juice scanty, sour; seeds 5 – 7 per fruit, ovoid, flattened, 12 – 15 × 8 mm, smooth, cotyledons green.

Flowering: October to November

Fruit ripening: September to October

Distribution: Nair & Nayar (1997) in *Flora of India* recorded its distribution in North-eastern India covering states on Assam, Manipur, Meghalaya and Nagaland. However, population structure is quite small.

Associated species: The dominant tree species around the *Citrus indica* population includes *Magnolia hodgsonii* (Hook.f. & Thomson) H.Keng, *Morus macroura* Miq., *Bauhinia variegata* L., *Elaeocarpus* sp, and *Actinodaphne obovata* (Nees) Blume in the top storey; shrubs and under-shrubs like *Chloranthus elatior* Link, *Coffea benghalensis* B.Heyne ex Schult. *Sterculia lanceolata* var. *coccinea* (Jack) Phengklai, *Clerodendrum laevifolium* Blume, *Dalhousiea bracteata* (Roxb.) Graham ex Benth., *Gnetum gnemon* L., *Phanera macrostachya* Benth., *Phlogacanthus* sp, and *Dracaena petiolata* Hook.f.; climbers like *Xanthoxylum* sp, *Dioscorea* spp, *Dalbergia* sp, *Caesalpinia crista* L., *Smilax blumei* A.DC., and in the herb or ground covering layer *Oplismenus burmanni* (Retz.) P.Beauv., *Mycetia nutans* (R.Br. ex Kurz) Razafim. & B.Bremer, *Tropidia curculigoides* Lindl., *Tacca integrifolia* Ker Gawl., *Amischotolype hookeri* (Hassk.) H.Hara, etc. are forming rich but slightly open vegetation in its habitat.

Threats to *Citrus indica* in Behali Reserve Forests

Behali Reserve Forest is housing many endangered and rare plants such as *Canarium strictum*, *Morus macroura* (Meena *et al.* 2012) including the Indian wild orange, *Citrus indica*. But the future of this species is a matter of concern as the primary tracts of forest in the region is very scarce and is facing high pressure due to illegal logging, extensive firewood collection, extension of human habitation and their too much dependence on forest products. Encroachment is a great concern and causing threat to the local wildlife as well. The area is located within the important elephant corridor for large scale migration (Kushwaha & Hazarika 2004). Out of BRF's total geographical area of 140.16 km², 60 km² is already encroached and the remaining 80.16 km² is also under anthropogenic exploitation. As it appeared, *C. indica* is a poor coloniser and under the present situation in BRF the increase of its population and expansion of habitat area seems to be difficult. Eventually, under the present situation, the species is now confined to single small patch within the entire BRF.

Personal interviews and open ended discussions with the people of surrounding and nearby villages and forest officials produced very less information on the utility of the plant, except its ripe fruits are sometimes eaten by locals. However, Nair & Nayar (1997) mentioned that fruits are inedible but the species can be used as root-stock for propagation of cultivated species.

Conservation issues

Aiming at the conservation of this wild citrus, *in situ* conservation practice seems to be the best possible option for the present study area as it was already reported that seed-grown cultivated plants do not flower in spite of their healthy vegetative growth, indicating its low adaptation to manmade habitats (Zeven & de Wet 1982). *C. indica* is a plant with

reports of use, intricate into the lives of Garo people in Meghalaya (Malik *et al.* 2006), though its known use in the present forest is yet to be evaluated. Its conservation as an important gene-pool resource in developing better cultivars in the future is understood. Moreover, it is clear that the elimination of this species, as well as its associated species will impact the overall stability of the ecosystem. In literature there is no record of its propagation through air-layering, but if it is successful, then its propagation can be faster and immediate flowering is expected.

DISCUSSION AND CONCLUSION

Citrus indica has been observed to be hardy and to be free from pests and diseases in its natural habitat (Malik *et al.* 2006). And if proper utilisation of this resistibility is necessitated it can provide good results (rootstocks, cultivated varieties) as most interspecific Citrus hybrids are fertile. To fast decline of the primary tracts of forests, these wild endangered plants need special and immediate attention for conservation due to their endemism and high degree of threat perception (Malik *et al.* 2006; Hynniewta *et al.* 2014). To protect these invaluable genetic resources of citrus, initiative was taken way back in 1981 by establishing the *Citrus Gene Sanctuary* in the Garo Hills of Meghalaya covering an area of about 10,266 hectares and is probably first of its kind in the world (Singh 1981), is endowed with highly specified microclimate with a combination of tropical and mild temperate seasons and experiencing very high humidity and rainfall.

Very soon other places holding the wild populations in North-east India should also to be conserved understanding its cultural and scientific importance. Behali Reserve Forest is just one such area, which holds a number of such rare and endangered floral wealth. Endowed with much suitable climatic conditions, the vegetation of BRF varies right from deciduous tropical forests to riparian forests and Tropical mixed forests. All these corresponds in creating a suitable microclimate, compared to the surrounding areas. Proposals for increasing the protection of the area, production of its viable seedlings or saplings and re-establishing those in the wild, in similar microclimatic condition, in addition to recognizing BRF as a *in situ* 'Citrus Sanctuary' is to be done immediately.

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