

Figure 1. Input form for statistical analysis.

ning information on how to use different features of the software package.

The Crop DNA Fingerprint Database is a user-friendly Windows-based computer package for storing and analysing profile data of crop varieties and genetic stocks. The package provides Windows GUI that makes software more accessible for the casual computer user and more convenient for the experienced computer user. Simple menus and dialogue box selections enable users to perform stati-

stical analysis and produce a scientifically sound report, thereby assisting in analysing the profile data using computational tools. This will be an important tool for scientists, researchers, plant breeders and those involved in DNA fingerprinting of crops. It would also provide an interface where the DNA profile can be stored and analysed.

1. Paetkau, D., Calvert, W., Stirling, I. and Strobeck, C., *Mol. Ecol.*, 1995, **4**, 347–354.

2. Botstein, D., White, R. L., Skolnick, M. and Davis, R. W., *Am. J. Hum. Genet.*, 1980, **32**, 314–331.
3. Bhat, K. V., Molecular Data Analysis. In Anonymous (eds.), NRC on DNA Fingerprinting Training Manual on Techniques for Plant DNA Fingerprinting 19–28 November 2001, NRC on DNA Fingerprinting, National Bureau of Plant Genetic Resources, New Delhi, 2001, pp. 46–58.
4. Bhattacharya, E., Dandin, S. B. and Ranade, S. A., *J. Biosci.*, 2005, **30**, 669–677.
5. Kirst, M., Cordeiro, C. M., Rezende, G. D. S. P. and Grattapaglia, D., *J. Hered.*, **96**, 161–166.
6. Nagaraju, J., Reddy, K. D., Nagaraja, G. M. and Sethuraman, B. N., *Heredity*, 2001, **86**, 588–597.

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Population status of *Gymnocladus assamicus*, a critically endangered tree species in Arunachal Pradesh

Arunachal Pradesh, northeastern state of India and part of the Himalayan hot-spot, harbours a large number of rare, endangered and endemic plant species due to its vivid climatic conditions. *Gymnocladus assamicus* is one such tree species of ecological and economic importance. It is categorized as critically endangered for its extremely small population and given conservation priority for effective management¹. The species is also listed for national recovery programme in India². It was first described and published in 1934 from Khasi Hills, Meghalaya. However, further information regarding

its demography and niche requirements are unknown. The present correspondence describes the existing population of *G. assamicus* in Arunachal Pradesh along with other autecological details.

Gymnocladus is a small primitive genus (Fabaceae: Caesalpinioidae) with only five species of which three species, namely *G. chinensis* Baill., *G. assamicus* Kanjilal ex. P.C. Kanjilal and *G. burmanicus* Parkinson are confined to the trijunction of India, China and Myanmar (Burma). While *G. diocus* (L.) K. Koch is native to the midwest of North America³, *G. assamicus* and *G. chinensis* are

known only from the northeastern states of India⁴. A phylogenetic study of eleven *Gleditsia* species along with two species of its sister genus *Gymnocladus*, showed that the two genera appear to have originated in eastern Asia during the Eocene⁵.

Extensive field visits were conducted during 2004–07 throughout Arunachal Pradesh to document the populations of *G. assamicus*. The populations were geographically marked with global positioning system (GPS) and the number of mature trees, saplings and seedlings was counted. Flower from each of the mature trees was collected and dissected care-

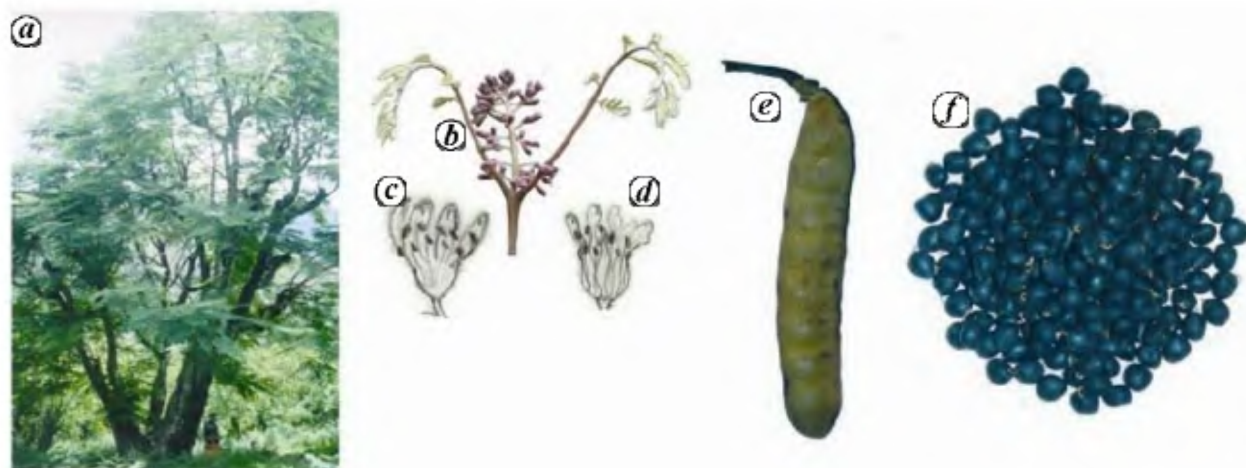


Figure 1. a, Mature *Gymnocladus assamica* tree; b, A complete inflorescence; c, Male flower; d, Hermaphrodite flower; e, Mature fruit; f, Mature seeds (Photo credit: B. I. Choudhury).

Table 1. Life-history and demographic characteristics of *Gymnocladus assamica* (based on three years of observation)

Characteristics	Observations
Leaf flushing	Early March to May
Flowering	Late March to mid May
Seed set	April to June
Fruit maturation	December to February
Seed dispersal	February to April
Average no. of fruits per mature plant	13,813 ($n = 5$)
Average no. of seeds per mature plant	74,451 ($n = 5$)
Average seed weight	1.95 g
Seed dispersal distance	0–12 m
% Greenhouse seed germination	42 (when fresh)

fully to understand the floral make-up. Regular field visits were conducted to record different phenological events. Laboratory experiments were conducted in the Department of Forestry, North Eastern Regional Institute of Science and Technology, Nirjuli, Arunachal Pradesh, India.

G. assamica Kanjilal ex. P.C. Kanjilal is a medium-sized (average 17 m) deciduous tree (Figure 1 a), locally called 'Mewangmanba-shi' by the Monpa tribe and 'Minkling' by the Lish Monpa tribe. The mesocarp is highly saponaceous and is used as an alternative for soap by the local tribes⁶. Tree bark is greyish-brown, having parallel furrows. Mature leaves are two-pinnate, 13–17 in long, swollen at the base and have 7–10 opposite or distantly sub-opposite pinnae. Tubular flowers are 12.7–20.32 mm long with purplish corolla borne on 3–7 in long shaggy racemes (Figure 1 b). The species

bears male and hermaphrodite flowers on separate trees. This was established from intensive floral study of different flowering tree populations. While male flowers (Figure 1 c) borne by male trees are slightly smaller in dimension (length 5.50 mm, width 3.43 mm), hermaphrodite flowers (Figure 1 d) are slightly larger (length 9.20 mm; width 3.74 mm) in dimension. Pods are 4–6.5 in. long by 1–1.5 in. diameter, having 4–8 seeds (Figure 1 e). Pericarp is polished and mesocarp highly saponaceous. Seeds are 15.21 mm by 17.24 mm in dimension, ovoid or subglobose in shape having black testa and are extremely hard (Figure 1 f). The life-history characteristics and demography of *G. assamica* is presented in Table 1.

During the present exploration, 28 mature trees were encountered from eight locations of Dirang Forest Range of West

Kameng district, Arunachal Pradesh (Table 2). The number of mature trees per location ranges from one to six. *G. assamica* trees are mostly found along the hillock slopes near small streams, rich in moisture and organic materials. Sandy-loam soil with 1.12–2.16 cm litter depth at Moishing (where maximum seedlings and saplings occurred) collected during December–January was somewhat acidic (pH 4.49 ± 0.04). Organic carbon was found $4.91\% (\pm 0.08)$, while total Kjeldahl nitrogen was $0.63\% (\pm 0.01)$.

The only means of regeneration observed in the species was through seeds. However, seedling population was absent in all other sites, except Moishing. Yewang village and Dambla Basti had only one sapling each. Total number of seedlings and saplings at Moishing were 160 and 11 respectively. There was a dense aggregated seedling population within 4–8 m radial distance, where 55% of censused seedlings occurred. On the other hand, density and survival of saplings was recorded only at 8–12 m radial distance, away from the crown of the mother tree. There was no seedling or sapling population beyond 12 m radius. Seeds with extremely hard seed coat had 42% germinability when fresh and retained viability of 6.7% even after 12 months of storage in normal laboratory conditions. Germination took place within 10–12 days from the day of sowing. However, new seed germination was also observed after three months of sowing. Vegetative mode of propagation was

Table 2. Distribution of *G. assamicus* in and around Dirang

Locality	Date of survey	Altitude (m)	Latitude (N)	Longitude (E)	No. of individuals		New recruits	
					Male	Hermaphrodite	Seedling	Sapling
Moishing	19.11.2004*	2052	27°18'	92°14'	1	1	160	11
Dirang Basti	21.09.2005*	1715	27°20'	92°15'	–	1	–	–
Changfu Moon	21.09.2005*	1960	27°21'	92°14'	4	–	–	–
Yewang village	19.11.2004*	1688	27°21'	92°14'	1	1	–	1
Dambla Basti	2.06.2005*	1723	27°23'	92°14'	5	2	–	1
Jyotinagar	8.01.2005*	1724	27°22'	92°14'	1	–	–	–
Runkung village	4.12.2006	1669	27°22'	92°15'	–	1	–	–
Lishpa village (Rama Camp)	26.04.2007	1870	27°23'	92°13'	5?	–	–	–
Lishpa village II (Rama Camp)	27.04.2007	1900	27°23'	92°13'	5?	–	–	–

*Also several field visits thereafter; ?, Sex unknown.

totally absent. Though coppicing was not observed in mature trees (due to unavailability of cut stump), seedlings in nursery conditions were found to have good coppicing.

Mature pods of *G. assamicus* are largely harvested by local villagers and stored for future use. Moreover, wild pigs, deer and cattle were found to eat the mature fallen pod. Arboreal animals like squirrel and field mouse also contribute to the damage of seeds. No seed-dispersing agents have been noticed during the fruit maturation period. Pods were found to absorb substantial amount of moisture that favours heavy fungal attack leading to complete damage of seeds in the soil. These activities simultaneously affect the natural regeneration of *G. assamicus*.

The present investigation shows that the population of *G. assamicus* is extremely low and the total number of reproducing individuals is far less than fifty. Therefore, the species may be designated as 'critically endangered'⁷. In such situation, active protection measures and continuous monitoring of the existing populations should be given priority in management plans. According to the demographic characteristics, it is found

that seedling and sapling populations do not contribute to the maintenance of natural regeneration rate. Thus, artificial introduction of the species in suitable ecological habitat may be one of the options to restore the populations of *G. assamicus*. *Ex situ* conservation in protected areas may also be recommended for effective restoration and management of the species.

1. CAMP report, Conservation Assessment and Management Prioritisation Workshop for Medicinal Plants of Arunachal Pradesh, Meghalaya and Sikkim. Foundation for Revitalisation of Local Health Traditions, Bangalore, 27 February to 1 March 2003.
2. Ganeshaiah, K. N., *Curr. Sci.*, 2005, **89**, 599–600.
3. Anon., http://en.wikipedia.org/wiki/Ken-tucky_coffeetree
4. Sanjappa, M., *Advances in Legume Research in India* (ed. Rao, R. R.), Bishen Singh Mahendra Pal Singh, Dehradun, 2002, pp. 27–34.
5. Schnabel, A., McDonel, P. E. and Wendel, J. F., *Am. J. Bot.*, 2003, **99**, 310–320.
6. Choudhury, B. I., Khan, M. L., Arunachalam, A. and Arunachalam, K., *Natural Prod. Radiance*, 2007, **6**, 427–429.

7. Frankel, O. T., Brown, A. H. D. and Burdon, J. J., *The Conservation of Plant Diversity*, Cambridge University Press, 1995, p. 299.

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