

Population assessment and distribution of *Cycas pectinata* Buchanan-Hamilton in Northeast India

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[Received 12.05.2014; Revised 30.05.2014; Accepted 31.05.2014; Published 30.06.2014]

Abstract

Cycads are globally one of the most threatened groups of plants, with 62 % of all species listed on the IUCN Red List (Nagalingum *et al.* 2011; IUCN 2011). The ongoing decline of cycad populations in India is not well documented as compared to other cycads of the world. *Cycas pectinata* Buchanan-Hamilton (Cycadaceae) is one of the most wide spread cycad is now under threat and its populations are declining at pace as compared to any other species of *Cycas*. In Northeast India, the cycad populations has shrunk to such an extent that it is almost at the verge of extinction from the region. In the present study, cycad population in Assam, Manipur, Sikkim, West Bengal, Arunachal Pradesh and Tripura were extensively surveyed in the field during 2007 to 2014. The paper highlights the current population status, range of distribution, phenology and threats to *Cycas pectinata* in Northeast India.

Key words: *Cycas pectinata*, Northeast India, distribution, threats population

INTRODUCTION

Cycas pectinata was first described by Buchanan-Hamilton in 1826 from “On the hills which bound Bengal to the east” with its habitat at “Camrupae sylvis”. Since its discovery from the forests of Kamrup in Assam, no extensive study was carried out to study its taxonomy, population status, range of distribution, reproduction, phenology and threats on Indian side of its distribution. Numerous small collections and explorations of *Cycas pectinata* plants and seeds have been made over the years in India (Hooker 1854; Griffith 1854a,b; Watt 1890; Kanjilal *et al.* 1940; Deb 1958; Srivastava 1993; Sahni 1990; Kar & Borthakur 2008). There is common belief that *Cycas pectinata* is abundantly found in northeastern states of India (Lindstrom & Hill 2007). Whitelock (2002) pointed out that *C. pectinata* is not a common plant outside its native habitat. They usually grow at elevation 300 m to 1200 m and in difficult terrains (Whitelock 2002; Jones 2002; Lindstrom & Hill 2007; Osborne *et al.* 2007; Singh & Singh 2010). Detailed population assessment of the species has not been carried so far for the Indian region of its distribution.

Study sites

Northeast India is located between 22-30°N latitude and 89-97°E longitude covering an area of 2,62,379 sq km Northeast India represents the transition zone between the Indian, Indo-Malayan and Indo-Chinese biogeographic regions and a meeting place of the Himalayan Mountains and Peninsular India. Northeast India constitutes the eight states Arunachal

Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. Northeast India can be physiographically categorized into three regions: a) the Eastern Himalayas, b) Northeastern Hills and c) the Brahmaputra and the Barak Valley plains. The region has a predominantly humid sub-tropical climate with hot and humid summers, severe monsoons and mild winters. Two-thirds of Northeast India is hilly terrain interspersed with valleys and plains with altitude ranging from sea level to 7000 metres. The forests in the region are extremely diverse in structure and composition and combine tropical and temperate forest types, alpine meadows and cold deserts (Ramakantha *et al.* 2001). Featuring diverse biota with a high level of endemism, Northeast India is unique in providing a profusion of habitats (Chatterjee 2006).

The study was carried out in three states of Northeast India viz Assam, Manipur, Sikkim and also in the northern part of West Bengal. Besides these four states, the survey was made in Tripura, Meghalaya and foothills of Arunachal Pradesh (Pakke Wildlife Sanctuary). However, no any natural populations of *Cycas pectinata*, except for few cultivated individuals, were recorded from these states. *Cycas pectinata* grows naturally in few districts of Assam at an elevation of 50 – 200 metres above mean sea level. These populations are highly scattered and are represented only by few individual trees. In Sikkim and West Bengal, *Cycas* trees usually grow at steep slopes of hills and on the bank of fast flowing rivers like Teesta and Rangeet. In Manipur, they grow at different landscapes ranging from hills to islands in Loktak Lake. Small hillocks protruding on the surface of the Loktak Lake and which is part of Keibul Lamjao National Park, the world's only floating national park is the last refuge of natural *Cycas pectinata* population in Imphal Valley.

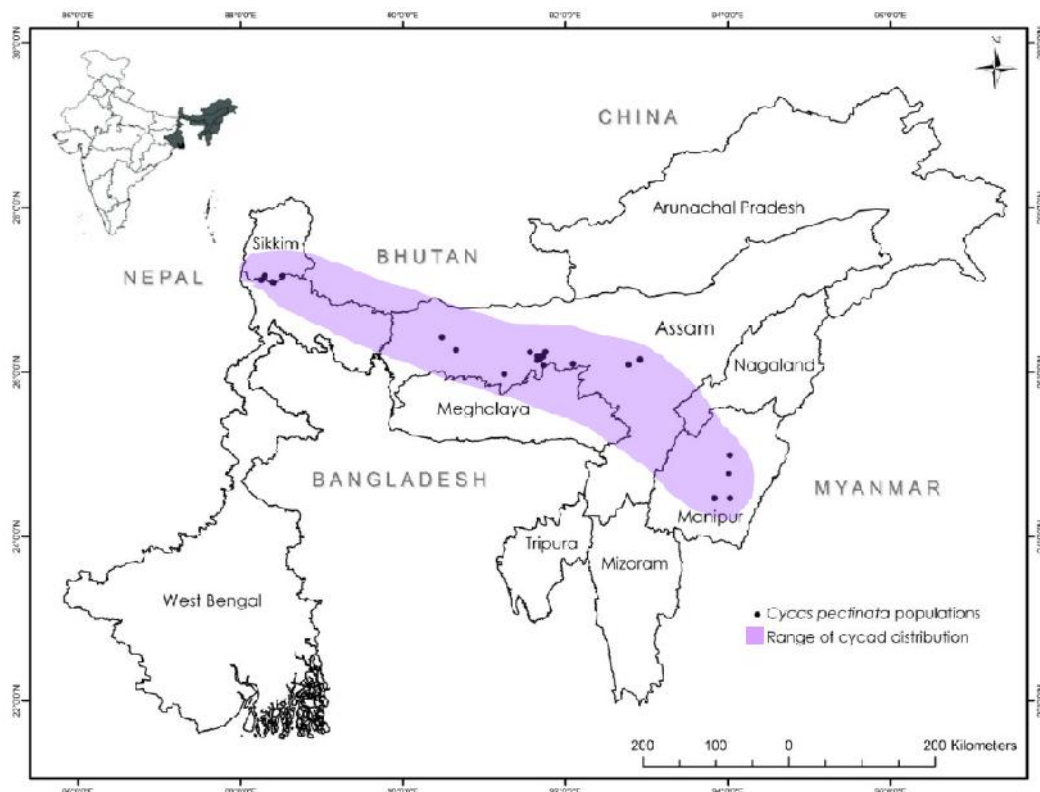


Figure 1. Map of Northeast India showing cycad populations and range of distribution.

Taxonomical description

Tall evergreen trees with crown of leaves at the apex of trunk. Stems robust, glabrous at base and usually branched when mature otherwise covered with leaf bases. Male and female cones are borne on separate plants i.e. dioecious. Leaves 1 to 2 m long, dark green. Leaflets 14 to 19 cm long and 8 – 12 mm wide, tapering to a minute spines. Male cones usually large and cylindrically ovoid, 22 – 56 cm long, 12 – 20 cm in diameter; mature cones yellowish or orange, microsporophylls numerous, compactly and spirally arranged around its thick central axis, 5 – 5.6 cm long and 2.6 – 3 cm wide, fertile zone 3.7 – 4.1 cm long, sterile apex 2 – 2.7 cm long, apical spine prominent and sharply upturned, abaxial side bears groups of sporangia or sori and each sorus contains 2 – 4 pollen grain filled sporangia. Female cones huge and compact; megasporophylls, close, deeply pectinate, densely covered with hairs and bear 2 to 5 ovules. Seeds ovoid, glabrous and orange to red-yellow on maturity.

MATERIALS AND METHODS

Data collection and analysis

The sites were visited annually during 2007 – 2014 to conduct population assessment and to collect phenological and taxonomical data. Using any signs of reproductive structures (based on the presence of cones or their remains), sex (male, female) or indeterminate was assigned to each individual. Forest structure, canopy openness and soil type were recorded. *Cycas* individuals were censused on 10 × 10 m plots. These plots were randomly selected so that different microhabitats containing *Cycas pectinata* Buchanan-Hamilton plants were reasonably represented. Plants were considered mature if they are above 90 cm. Structure of the cycad populations was characterised in four states: Assam, Manipur, Sikkim and in the northern part of West Bengal. Population size and distribution pattern were determined. For data analysis, IBM SPSS Statistics 20 is used and for plotting graphs Origin 8.5 is used. Locations of different populations were demarcated using Garmin GPSMAP78.

RESULTS

Natural populations of *Cycas pectinata* Buchanan-Hamilton of four states in Northeast India were located for the first time. 19 natural populations consisting of 272 individuals were identified from the sixteen field expeditions (Table 1). The number of reproductive plants is not proportional to number of individual plants. Sex ratio is uneven. Assam has the

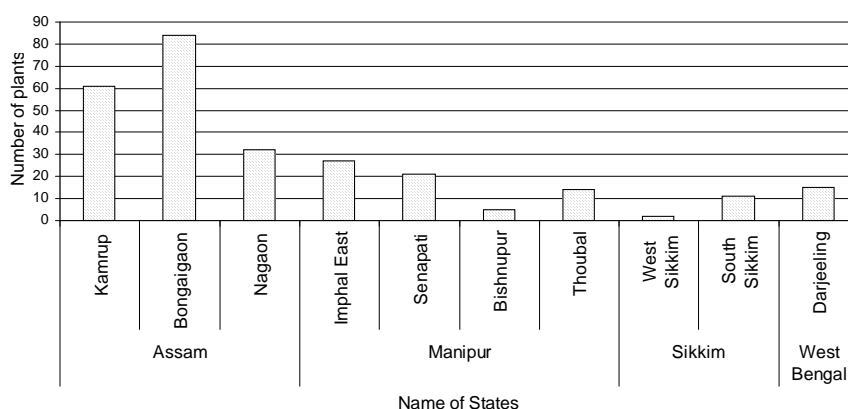


Figure 2. District-wise comparison of number of *Cycas* population in four states of Northeast India.

Table 1. *Cycas pectinata* Ham. populations of Northeast India [N: Number of individuals; M: Mature plant; m: Male plant; f: Female plant]

| Population | | Altitude (amsl) | N | M | m | f |
|---------------------------------|-------------------|--------------------|-------|----|---|---|
| A. ASSAM | | | | | | |
| Kamrup District | | | | | | |
| Amingaon | 1. North Guwahati | 52 m | 7 | 5 | 4 | - |
| Soratani Pahar | | 54 m | 4 | 4 | 2 | - |
| Tilingaon | | 55 m | 1 | 1 | - | - |
| Dol Gobinda (Aswaklanta) | | 80 m | 2 | 2 | 1 | - |
| Dirgeshwari Pahar | | 100 m | 5 | 5 | - | - |
| Sheela Pahar | | 192 m | 6 | 6 | - | - |
| IIT Campus | | 60 m | 7 | 5 | 1 | 2 |
| 2. Hajo | | | 178 m | 10 | 6 | 5 |
| 3. Basistha | | 112 m | 5 | 2 | - | 1 |
| 4. Khetri | | 110 m | 3 | 3 | - | 1 |
| 5. Boko | | 93 m | 4 | 2 | - | 1 |
| 6. Kamakhya Pahar | | 143 m | 3 | 3 | - | - |
| 7. Jalukbari | | 99 m | 4 | 2 | - | - |
| Bongaigaon District | | | | | | |
| 8. Maleghar | | 124 m | 70 | | - | - |
| 9. Bhumeshwar | | 77 m | 14 | 14 | 1 | - |
| Nagaon District | | | | | | |
| 10. Doboka | | 93 m | 32 | 20 | 4 | 2 |
| B. MANIPUR | | | | | | |
| Imphal East District | | | | | | |
| 11. Nongmaiching | | 923 m | 27 | 20 | 2 | 1 |
| Senapati District | | | | | | |
| 12. Sadar Hills | | 1154 m | 21 | 21 | 1 | 2 |
| Thoubal District | | | | | | |
| 13. Kakching Lamkhai | | 833 m | 14 | 10 | - | - |
| Bishnupur District | | | | | | |
| 14. Keibul Lamjao National Park | | 772 m | 5 | 3 | - | - |
| C. SIKKIM | | | | | | |
| South Sikkim District | | | | | | |
| 15. Turuk, Rangeet Valley | | 270 m | 1 | 1 | - | - |
| 16. Kerabari, Rangeet Valley | | 269 m | 1 | 1 | - | 1 |
| 17. Rangpo, Teesta Valley | | 319 m | 9 | 9 | - | 2 |
| West Sikkim District | | | | | | |
| 18. Pippalay, Rishi Khola | | 395 m | 2 | 2 | - | - |
| D. WEST BENGAL | | | | | | |
| Darjeeling District | | | | | | |
| 19. Goke Forest, Singla | | 637 m | 15 | 12 | 1 | - |

highest number of *Cycas* individuals which accounts for the 65 % of the total number of *Cycas* individuals in the four states. Bongaigaon district has the highest number of plants followed by Kamrup district, which have very scattered distribution. *Cycas* populations in Bongaigaon are confined to only two localities, Maleghar and Bhumeshwar. Out of the 61 cycad individuals of Kamrup, only 5 are females, 13 are males and remaining is indeterminate.

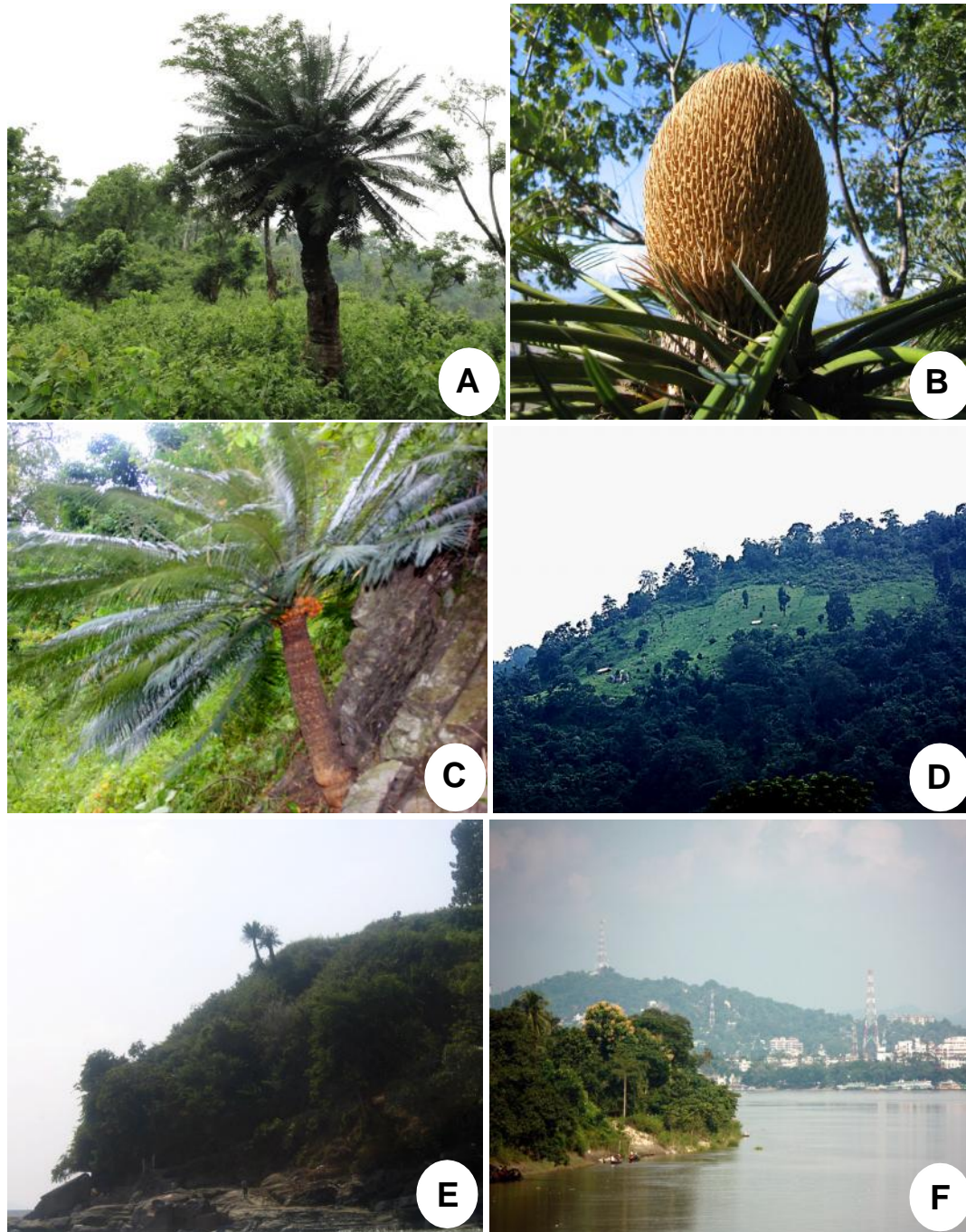


Figure 6. *Cycas pectinata* Buchanan-Hamilton populations: **A.** A mature *Cycas* tree in natural habitat at Bongaigaon; **B.** A male cone in Nongmaiching Hill Range in Manipur; **C.** A female plant growing on a rocky cliff on the bank of Teesta River in Sikkim; **D.** Clearing for forest in cycad locality in East Kamrup; **E.** Fragmented cycad population on the bank of Brahmaputra River; **F.** Ever expanding Guwahati city on the bank of Brahmaputra River.

22 Distribution of *Cycas pectinata* in Northeast India

In Sikkim, there are 13 individuals in which three are female plants and not a single male plant left is in the wild. In Manipur, *Cycas pectinata* grows in different habitats. They grow on the hills overlooking oval shaped central Imphal valley. Interestingly three plants are growing on the island inside the Keibul Lamjao National Park and two on the adjoining hills.

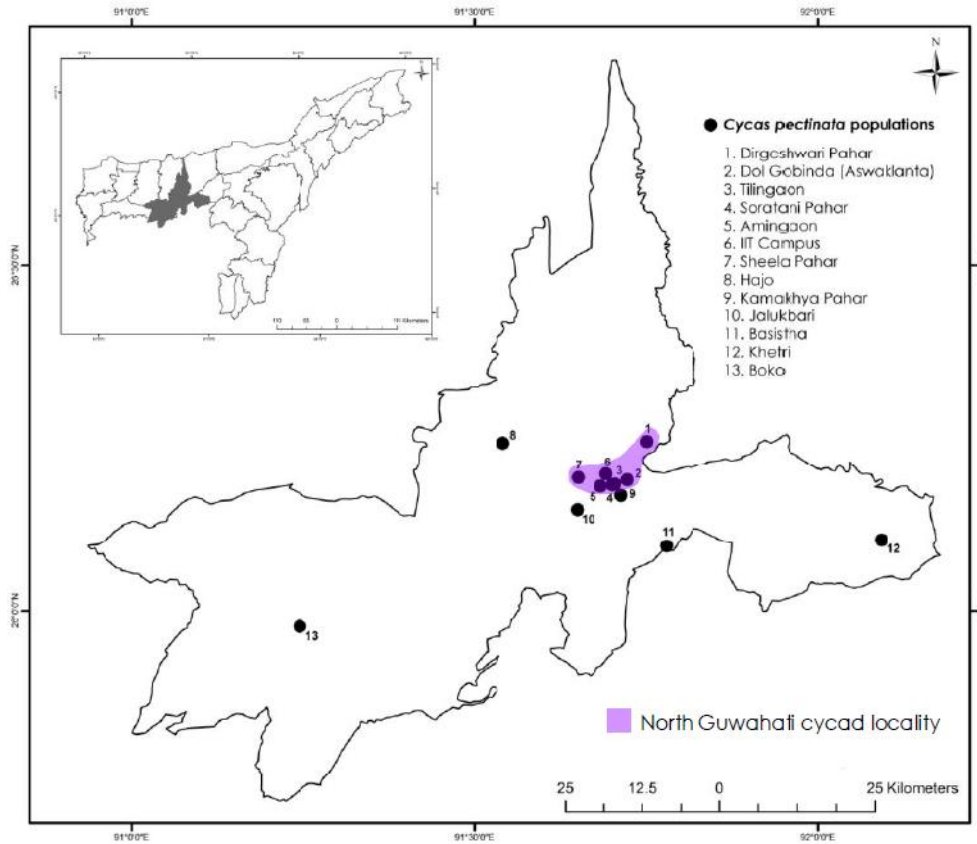


Figure 3. *Cycas pectinata* Buchanan-Hamilton populations in Kamrup district, Assam.

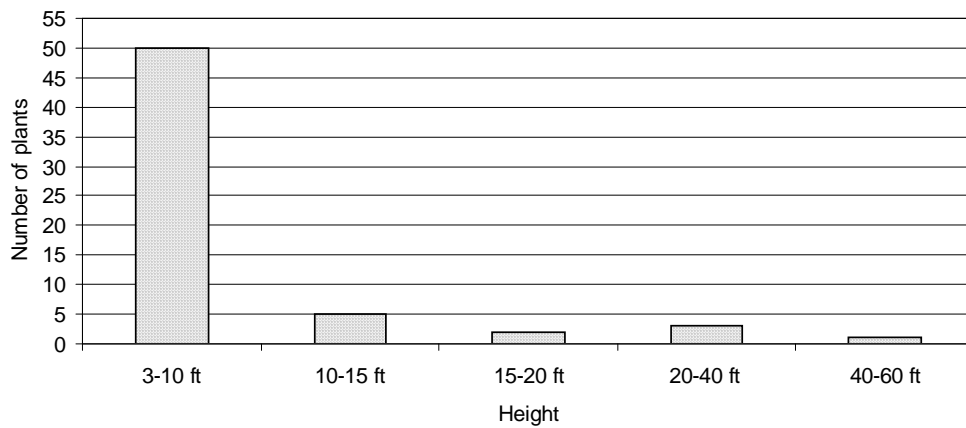


Figure 4. Relationship between the number of *Cycas pectinata* Ham. plants and height of plants in Kamrup district, Assam.

Cycad populations of Kamrup district have wide spread distribution though scattered due to fragmentation of habitats due to urbanization (Fig. 3). Populations in North Guwahati are closely located to each other. Nearest distance between the two populations i.e. Soratani Pahar and Tiligaon is 450 m, while 11.5 km is the longest distance, Sheela Pahar and Dirgeshwari Pahar. Hajo located at the west of the North Guwahati cycad locality, is an isolated population which is under threat from over-collection of leaves for decoration or ornamental uses in Fancy Bazar in Guwahati City and over-harvesting of male cones for folk medicine. Though Jalukbari and Kamakhya Pahar populations lie on the southern bank of Brahmaputra River, are quite near to the North Guwahati cycad locality which is only 2 – 5 km distance apart. Khetri on the eastern Kamrup and Boko on the western Kamrup are isolated cycad localities.

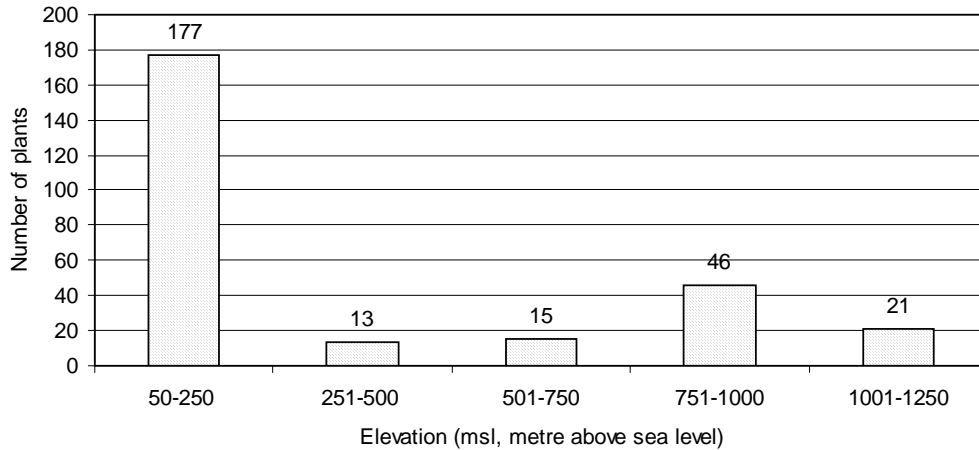


Figure 5. *Cycas* population at different elevations.

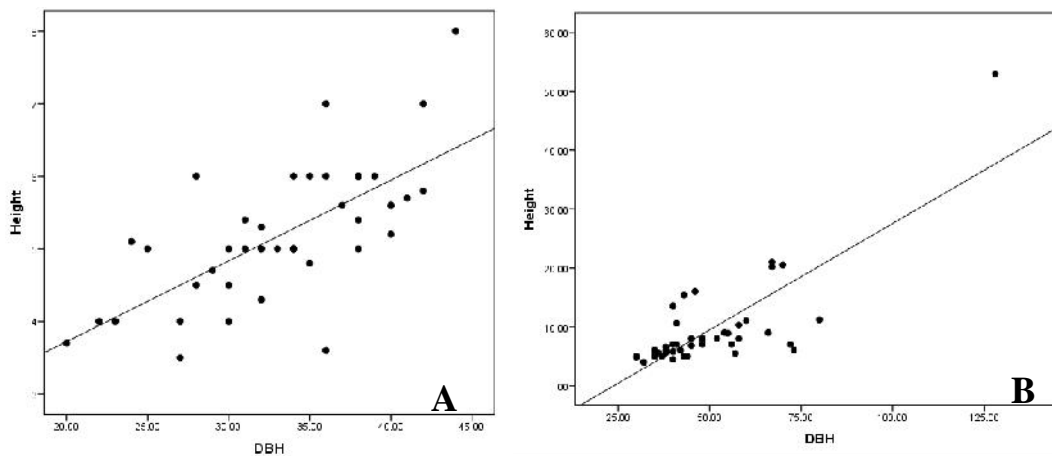


Figure 6. Relationship between the height and trunk diameter at breast height (DBH) of the *Cycas* plants. A. Manipur (Imphal East, Senapati and Bishnupur) ($R^2 = 0.497$). B. Assam (Kamrup) ($R^2 = 0.619$). Height (in feet), DBH (in cm).

Cycad populations of Kamrup in Assam and almost all existing populations of Sikkim are located on steep slopes of river banks. Though *Cycas pectinata* usually grow at elevation 500 – 800 m in other countries (Lindstrom & Hill 2007; Osborne *et al.* 2007; Hill 2004; Jones 2002), they grow at very low altitude in Assam. *Cycas* populations growing on the

bank of Brahmaputra in Kamrup district are at the range of 52 – 192 m above mean sea level. In Sikkim, the populations occur in the warm foothills which range between 250 to 400 m amsl. Manipur has cycad populations with highest elevation of 1154 m. However, most of the populations are at the range of 770 – 900 m.

Cycad populations of Assam and Manipur vary significantly in height and DBH of the trunk (Fig. 6). In the study, *Cycas* plants of Kamrup are used to represent *Cycas* plants of Assam while *Cycas* plants of Bishnupur, Imphal East and Senapati are used to represent Manipur. *Cycas* plants of Assam are comparatively taller and larger in girth of the trunk than those of Manipur. Mean of height and DBH of *Cycas* plants of Assam is 9.629 ft and 50.43 cm respectively. Mean of height and DBH of *Cycas* plants of Manipur is 5.27ft and 33.38 cm respectively.

DISCUSSION

Cycas pectinata Buchanan-Hamilton is usually considered to be widespread and abundant (Lindstrom & Hill 2007; Hill 2004; Jones 2002; Whitelock 2002; Hill & Yang 1999). However, the present study contradicts this general speculation. Not only less in number, the cycad populations are disjunct, very scattered and are prone to destruction. Only 272 plants are left in the wild in Northeast India. Deb (1981) recorded cycad populations in Tripura however during the present study we couldn't locate them. In Manipur, several populations of *Cycas pectinata* got submerged under water during the construction (1982 – 2010) of Khuga Dam in Churachandpur district. Assam has the highest number of *Cycas* plants and wide range of distribution, are the worst affected state due to the habitat destruction and over harvesting for medicine, decoration and rituals. Expansion of Guwahati city in Kamrup district in the state has severely threatened the already diminishing cycad populations. Establishment of Indian Institute of Technology (IIT) on North Guwahati located on northern bank of Brahmaputra River has led to mass destruction of cycad populations.

Huge *Cycas* trees were hacked for construction of high-rise buildings of the institution. During the course of the study, the only two mature female plants in Northern Kamrup which were growing in the IIT Campus were cut down. This will further complicate the already uneven sex ratio of this natural but fragile cycad locality. All the populations on either bank of Brahmaputra are now prone to destruction as those are disjunct populations located within the fast expanding Guwahati City. Cycad localities of Northeast India need conservation and this can be achieved only through urgent identification of threats and protection the habitats from those. The species needs to be listed as Endangered (EN) for the Northeast region of India and be added to Red Data book of Indian Plants. State governments and Central government need to take up conservation initiatives to protect and conserve the remaining populations before they got diminished from the region. Designation of conservation sites will help in long term conservation of the species. Further extensive surveys are required in Darjeeling district in West Bengal, Western Assam, Karbi Anglong and North Cachar Hills in Eastern Assam, Eastern Meghalaya and Manipur.

Acknowledgments

State Forest Departments and officials of Assam, Manipur, Meghalaya and Sikkim are gratefully acknowledged for their unconditional cooperation and support. Ministry of Environment and Forests, Government of India [AICOPTAX (J-22018/09/2004)], Critical Ecosystem and Partnership Fund (CEPF) and Ashoka Trust for Research in Ecology and Environment provided grant-in-aid for the research to Dr. Rita Singh. The first author thanked GGSIPU, Delhi for support through Doctoral Research program of the university and Ministry of Environment and Forests, Government of India for Senior Research Fellowship.

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