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COMMUNICATION

STATUS AND CONSERVATION NEEDS OF *CYCAS PECTINATA* BUCH.-HAM. IN ITS NATURAL HABITAT AT BAROIYADHALA NATIONAL PARK, BANGLADESH

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Status and conservation needs of *Cycas pectinata* Buch.-Ham. in its natural habitat at Baroiyadhala National Park, Bangladesh

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Abstract: The widespread cycad *Cycas pectinata* was first discovered in the Bengal region by William Griffith in Baroiyadhala forest of Chattogram in 1838. In Bangladesh, this species is confined to a few hills at Baroiyadhala, Sitakunda upazila of Chattogram district. Though the Baroiyadhala forests were declared a national park in 2010, the loss of this native gymnosperm from this forest is alarming. The present study aimed to assess the status of *C. pectinata* populations in its native range, identify the drivers responsible for ongoing losses, and identify locations of *C. pectinata* occurrence in Baroiyadhala National Park suitable for in situ conservation. A random quadrat survey with 21 sample plots of 100 × 100 m was conducted during April–June 2018 in Baroiyadhala National Park. Population and growth data for *C. pectinata* were collected from each sample plot, along with observations of disturbances. Four focus group discussions (FGDs) were conducted with adjacent local people. The study revealed presence of 12 *C. pectinata* individuals per hectare and five seedlings per hectare in the study area, and significant numbers of dead and burned Cycas were also found in some sites. Based on density, five *C. pectinata* hotspots were identified for in situ conservation programs. Habitat destruction, indiscriminate fire, and unsustainable harvesting of leaves and male and female cones are responsible for rapid declines in *C. pectinata* populations in its wild habitat. Measures for protection and restoration of the species are creating awareness among the local people about ecological importance of this species; enhancing protection; banning trade of Cycas; creating opportunities of sustainable livelihood for local people to reduce dependency on forests.

Keywords: habitat destruction, in situ conservation, IUCN Red List, protected area, natural regeneration, stand structure, species association, unsustainable harvesting.

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INTRODUCTION

Cycads are an ancient group of seed plants that originated over 280 million years ago. Globally, there are 10 genera and 352 species of cycads, with 117 species belonging to the genus *Cycas* (Stevenson et al. 2018) under the Cycadaceae family. In the Indian subcontinent eight species of *Cycas* are reported, among which only *Cycas pectinata* grows naturally in Baraiyodhala, Bangladesh (Lindstrom & Hill 2007). The species was first recorded in 1826 by Buchanan-Hamilton in Bengal. Natural distribution of the species is reported from Bhutan, China, India, Laos, Myanmar, Nepal, Thailand, and Vietnam (Stevenson et al. 2018).

Cycas pectinata Buch.-Ham., commonly known as Cycas, is an evergreen palm-like tree up to 3m in height that was first discovered by William Griffith from Baroiyadhala forest of Chittagong in 1838. Additional descriptions of the species were later added by Lindstrom & Hill (2007), Khuraijam & Singh (2014), and Stevenson et al. (2018), along with many other researchers. In Bangladesh, it is naturally confined to a few hills near Baroiyadhala in Sitakunda (Khan et al. 2001; Rahman 2006; Dutta et al. 2014; Harun-Ur-Rashid et al. 2018). The present Baroiyadhala National Park (BDNP) is one of the main native sites of Cycas species in the country. The species is very important to the locals, e.g., leaves of Cycas are widely used for bouquets, megasporophylls are sold in the local markets as the seeds are thought to be aphrodisiac. The stem yields coarse sago, which with the fruits is eaten by the hill people in Sikkim (Watt 1889). Similar uses of C. pectinata were also reported from northeastern India by Khuraijam & Singh (2015). Singh & Khuraijam (2010) mentioned that population of this species becoming endangered in several regions of India. Widespread illegal extraction of the reproductive parts (male and female cones) limited the distribution and sustainable reproduction of C. pectinata (Khuraijam & Singh 2016). In addition, habitat degradation causes rapid dwindling of populations in its native ranges. Moreover, the population of wild Cycas is further decreasing due to habitat degradation and forest fire.

Few conservation measures have been taken in Bangladesh for protection of the species, aside from declaring Baroiyadhala as a National Park. If the current situation prevails and proper conservation initiatives are not initiated, it may further reduce the existing small population of *C. pectinata* and ultimately cause regional extinction (Singh & Khuraijam 2010). To conserve the remnant *C. pectinata* population in its wild habitat, it is important to know the present status (e.g., density, distribution, regeneration) and the threats of the species in its natural ranges. Unfortunately, there is dearth of information regarding the population structure, distribution, regeneration, disturbances, and prominent threats of *C. pectinata* in its natural habitat of Bangladesh.

The present study aimed to assess of the status of *C. pectinata* in its native range of BDNP, measure the extent of disturbances (i.e., death, illegal cutting, burnt), identify threats, and recommend conservation needs. Findings are expected to be helpful in preparation of a comprehensive in situ conservation plan for this species. The study is also expected to be helpful for a regional threat assessment of the species and which may turn out the species to have higher threat status than that given in global assessment.

METHODS

Study area

Baroiyadhala National Park (BDNP) lies between 22.650–22.783N latitude and 91.583–91.683E longitude covering an area of 2,933.61 ha in the hilly area of Sitakunda and Mirsharai upazilla of Chattogram district. BDNP is under the jurisdiction of Chittagong North Forest Division and includes the entire area of Baroiyadhala and Wahedpur blocks of Baroiyadhala forest beat and Kunderhat block of Bortakia forest beat under Baroiyadhala Forest Range. The National Park is located approximately 207 km south-east from Dhaka and 40 km north from Chattogram city. BDNP, consisting of tropical semi-evergreen forests, was established in 2010 through a gazette notification under Bangladesh Wild Life (Preservation) (Amendment) Act, 1974.

The area is characterized by tropical monsoon climate. The south-west monsoon provides the majority of the annual rainfall. Average annual rainfall of the area is 3,000 mm with a range of 1,611–3,878 mm. On average highest rainfall occurs in July (727 mm) and the lowest rainfall in January (5–6 mm). Temperature range of the area is 12.5– 37 °C. Temperature and humidity range 7.2–38.9 °C and 67–88 % respectively round the year (Hossain 2015). The low hill ranges cover part of Hazarikhil Wildlife Sanctuary (HWS) while the rest is in the Bengal flood plain. The soils in this area range from clay to clayey loam on level ground and from sandy loam to coarse sand on hilly land.

Community Development Centre (CODEC) with support from the BFD and United States Agency for International Development (USAID) established forest co-management program in the BDNP in November 2014 under the Climate Resilient Ecosystems and Livelihoods (CREL) project (USAID 2018). It formed the co-



Figure 1. Location of the sample plots and high-density areas of *C. pectinata* at Baroiyadhala National Park of Bangladesh.

management committee (CMC) which had a critical role in protecting the forests. Though, now-a-days, due to lack of financial supports, the CMC activities are very limited but, apparently, the CMC played significant role in the governance and management of the protected area. The FD conducted afforestation and enrichment plantations for increasing green coverage and restoration of degraded forests. A large number of the surrounding communities from both Mirsharai and Sitakunda upazila are more or less dependent on the landscape for different types of forest resources. It is supposed that, all these may have greatly influenced the overall forest condition.

Field data collection

Field data for the study is collected *C. pectinata* population and natural regeneration related data through surveying randomly selected quadrats in the forests of BDNP. In addition, a community consultation in the form of focus group discussion (FGD) has been made to identify the threats, possible solutions to those threats and finding effective ways of conserving *C. pectinata* habitats.

Forest survey

C. pectinata occurs sporadically being mixed with other mixed- and semi-evergreen tropical hardwood tree species in the hilly terrain of BDNP. Simple random sampling (SRS) was appeared to be one of the simplest and appropriate method to study the Cycas species considering its distribution, overall forest conditions along with the time and scope of the study following Kohl & Magnussen (2016). SRS provides the same selection probability for all possible distinct samples (Schreuder et al. 2004; Kohl et al. 2006). A total of 21 quadrats of 100 × 100 m size were laid to cover a sample intensity of about 0.72%. Total height, diameter at base (10 cm above the ground) and top (just beneath the base of lowest frond), number of fronds of all the Cycas individuals were collected from each plot. The tree species occurred in the sample plots were treated as the associated tree species of C. pectinata and recorded with the names along with the nature of origin. Numbers of seedlings were also counted and recorded from the same sample plot to assess the natural regeneration status of this threatened species. Cycas having ≤10 cm total height was defined as regeneration. Disturbances (i.e., fire, illegal cutting, etc.) to the Cycas, if observed during the quadrat survey, were also recorded.

Focus group discussion

FGD is commonly used to explore and construct knowledge about a particular topic in small groups (Liamputtong 2011; Krueger & Casey 2015). It has been proved as an efficient and informative tool for conducting participatory research data collection regarding different aspects of forests at local level by Kumer & Urbanc (2020) and Egunyu et al. (2016). Encouraged by the popularity of qualitative research tools for empathizing the link between forests and society, we used FGD to explore the prevailing threats to the Cycas following the methods of Miller & Scoptur (2016) and Kumer & Urbanc (2020). Four FGDs were set for gathering community perceived information about C. pectinata. The local stakeholders were consulted in the FGDs at four different locations of BDNP. The FGDs were guided through a semi-structured questionnaire. Community perceived information about the distribution of the Cycas, present status in its natural territory, threats and possible control measures to the existence and natural regeneration of the species were discussed. Finally, a stakeholder consultation meeting in the Baroiyadhala CMC office was conducted to obtain community opinions and recommendations in order to prepare a future conservation strategy.

Data compilation and analysis

The quadrat survey data were compiled in MS Excel for assessing the density and stand characteristics (i.e., average height and diameter) following Sharma & Zhang (2004) and Caceres et al. (2019). Based on the higher density of Cycas individuals, five locations of higher abundance were marked in BDNP. Pearson correlation was used to compare terrestrial tree species with density of Cycas. The qualitative information gathered from the FGDs was presented as tables and visuals. Based on the FGD data, we computed the community perceived extent of the imminent threats to this species. The probable solutions to the identified threats and proposed conservation measures were emphasized as per the priority given by the communities.

RESULTS AND DISCUSSION

C. pectinata population

The quadrat survey revealed that density of C. pectinata individuals is 11.57±1.88 stem/ha and distribution varied across the BDNP. Inside the BDNP, numbers of individuals varied from one in Khoiyatoli to 26 stem/ha in nearby areas of Napittachara and Fhulgazi villages. The species occurs mainly in the steep hill slopes and altitudes ranging from 30-150 m. A few individuals were also found on the stream banks. However, in some localities i.e., Khoiyachara and Bhawadhala of BDNP, no C. pectinata were observed. Khuraijam & Singh (2014) mentioned presence of this species near water bodies in India. Moreover, they reported higher density of this species at 50–250 m altitude. The species is found at 1,250 m altitude though the usual distribution is 500-800 m (Lindstrom & Hill 2007; Osborne et al. 2007). Considering the density of C. pectinata in BDNP, five high density areas were identified and shown in the map (Figure 1). The C. pectinata specific conservation and management activities may be emphasized centering these highdensity locations but not ignoring the low-density areas.

Associates tree species of C. pectinata

Field observations indicated that *C. pectinata* grows below the canopy of both native and exotic tree species in both natural (i.e., Amloki *Phyllanthus emblica*, Bahera *Terminalia bellirica*, Bhadi *Lannea coromandelica*, Chatim *Alstonia scholaris*, Dumur *Ficus hispida*, Kanchan *Bauhinia acuminata*, Koroi *Albizia procera*, Sheora *Streblus asper*, and Simul *Bombax ceiba*) and plantation forests (i.e., Akashmoni *Acacia auriculiformis*, Gamar *Gmelina arborea*, Jarul *Lagerstroemia speciosa*, South American Raintree *Albizia saman*, and Segun *Tectona grandis*).

Ficus hispida is the most widely occurring species (52.4% sample plots) in the study area followed by T. grandis and B. acuminata (each with 42.9% sample plots) and A. saman and A. auriculiformis (each with 38.1% sample plots). Comparatively higher positive correlations (Pearson correlation +0.41) was found between C. pectinata and B. acuminata followed by S. asper (Pearson correlation +0.25) and B. ceiba (Pearson correlation +0.20). The study indicates that positive correlation of the density of Cycas exists with only native tree species except S. saman (Pearson correlation +0.19) which is a naturalized exotic tree species in Bangladesh. Besides, occurrence of Kuruch Holarrhena antidysenterica showed comparatively higher negative correlation (Pearson correlation -0.29) with density of Cycas followed by Sungrass (Imperata cylindrica, -0.23). However, none of the positive correlations were statistically significant. Singh & Khuraijam (2010) mentioned Bamboo, Rattans, and Sal Shorea robusta as the associated species in Sikkim and West Bengal of India but in BDNP we haven't found these species in association of C. pectinata. It indicates growth of the Cycas with wide range of associated species.

C. pectinata stand characteristics

Stand structure of *C. pectinata* in BDNP is presented through total height (0.96 ± 0.12 m), base diameter (9.72 ± 1.21 cm), top diameter (5.11 ± 0.57 cm) and number of leaf (10 ± 0.90). The mean stem height of *Cycas* varies from 0.72 m to 1.42 m in BDNP, whereas the highest

Location of plots	n*	Average total height (m)	Average base dia. (cm)	Average top dia. (cm)	Average number of leaves
Dottorichora	18	0.72	9.68	4.71	10
Jambagan	26	1.42	13.58	6.78	13
Amtola	21	1.03	9.50	5.40	12
Fhulgazi	26	0.93	10.65	5.74	10
Taraghona Hill	22	0.72	5.18	2.93	7

Table 1. Stand parameters of C. pectinata in five identified hotspots of Baroiyadhala National Park.

*n= Number of individuals sampled per location.

height (1.42 m) of the species is recorded from Jambagan (Table 1). Jambagan is also represented by *Cycas* with highest average base and top diameter (13.58 cm and 6.78 cm, respectively). The average number of leaf per *Cycas* plant varied from 7 in Taraghona to 13 in Jambagan. It seems that *Cycas* in Jambagan is in better health than other hotspots. *Cycas* can grow up to 18 m as reported by Khuraijam & Singh (2014) from northeastern India where they showed that most of the Cycas were between 1–3 m height range. The mean height and DBH of this species in Assam are 3 m and 15 cm, respectively, whereas height and DBH are 1.6 m and 10 cm, respectively, in Manipur. The study methods differ, but provide an overall impression that *C. pectinata* growing in BDNP are close to those of Manipur in terms of height and diameter.

C. pectinata regeneration status

This study provides insights into the status of natural regeneration of C. pectinata through the assessment of the number of seedlings per hectare. The forest survey revealed that there were about five C. pectinata seedlings per hectare area of BDNP. The density of seedlings varied widely across the national park. In the five high density locations, the seedling density varied from 7 seedlings/ha in Dottorichora to 14 seedlings/ha in Taraghona hill (Figure 2). The reproductive rate of *C. pectinata* is also very small in Sikkim and West Bengal (Singh & Khuraijam 2010). There are a number of reasons behind the poor natural regeneration. Cycads are slowly growing plants taking 3-10 years to become sexually mature (Dyer 1965). Cycads can reproduce naturally using both short-lived seeds and stem offshoots or suckers (also called pups) (Demiray et al. 2017). The seeds of Cycas spp. are held in the cones for about nine months. Very few seeds germinate in nature, resulting in few seedlings in the wild and thus decline of Cycads (Forsyth & Staden 1983). Moreover, Cycads are dioecious plant and only very rarely the timing of cone development in male and female plants match (Cheek 2000; Lindstrom & Hill 2007). Woodenberg et al. (2010, 2014) mentioned rare pollination and sensitivity of seeds to desiccation as two more reasons for poor natural regeneration of Cycads.

Disturbance indicators to C. pectinata in the wild

Anthropogenic disturbances, i.e., cutting, collection and forest fires were observed in BDNP, which severely affected the *C. pectinata*. Illegal cutting of *Cycas* at a rate of 0.29 (\pm 0.21) stem/ha is observed across the study area, whereas number of *C. pectinata* damaged by fire is 0.81 (\pm 0.61). Two percent of the *C. pectinata* population is affected by illegal cutting, while forest fires affected



Figure 2. Density of *C. pectinata* seedlings in Baroiyadhala National Park.



Figure 3. Percentage of respondents opined about the severity of disturbances.

about 5.9% of the population. Fire is severe in some locations of BDNP, e.g., Hutukhola and Dottorichora. Moreover, there are other anthropogenic disturbances like collection (i.e., Cycas leaf for decoration, sporophylls for medicinal purpose), habitat destruction through excessive extraction of forest resources, trade of Cycas plant, grazing, agricultural expansion, etc. (Figure 3). The forest survey indicated the number of died C. pectinata individuals is 1.95 (±1.21) individual/ha. Taking into account the loss due to forest fire and illegal cutting, the study estimated that about 7.8% of the total C. pectinata population is being lost due to the disturbances. However, the simultaneous natural regeneration of the species may fill the loss and restore the C. pectinata population if protected from disturbance. Mortality of Cycas is high in a number of locations, i.e., Hutukhola (12 individuals/ ha), Dottorichora (5 individuals/ha), Ruposhijhorna (3 individuals/ha), and Khoiyatoli (2 individuals/ha).

Threats to C. pectinata in BDNP

The study identified 10 prominent threats to Cycas through FGD and field observation. The threats may put the species at higher danger in near future if left unattended. Fire infestation, over-exploitation of forest

Table 2. Suggestion	s to address threats	mentioned by the	participants of FGD
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	Threats	Suggestions to address the threats	
1	Anthropogenic habitat destruction	 Regular patrolling by BFD staff; Raising mass awareness among people living in vicinity of the National Park about the importance of habitat protection; Regular meeting between BFD and local stakeholders; Collection of monitoring data for assessing habitat indicators to track the changes of habitat quality. 	
2	Extraction of forest resources	 Forest law enforcement; Creating opportunity for alternative livelihood generation of the forest dependent local people (i.e. providing AIGA, training for diversifying income sources, promoting eco-tourism etc.); Raising mass awareness about the importance of maintaining natural habitat of <i>C. pectinata</i>; Empowering existing CMC for persuading people to stop illegal forest resource extraction; Regular field visits and meeting with the local people might help. 	
3	Cycas extraction	 Forest law enforcement for <i>C. pectinata</i> plant part (i.e. leaf, fruit) collectors and users; Involving CMC for motivating local collectors and protecting <i>Cycas</i> population; Banning collection of cones or sporophylls for any medicinal purpose; Strict prohibition of selling or buying any Cycas plant parts; Installing signboard and posters in relevant locations about the offences and associated punishments for <i>Cycas</i> collectors. 	
4	Fire infestation	 Enforcement of strict rules and regulations for not allowing smoking in the forest, making any fire for any purpose and doing any interference in the forest which may be a reason to create fire inside forest; Formation of local fire response team; Raising mass awareness about the damaging impact of fire; Make fire lines around conservation plots; Involving CMC for monitoring and fighting fire in BDNP. 	
5	Grazing	Control grazing in terms of Forest Act and PA Management Rules; Involving CMC to help local BFD staff to control grazing;	
6	Hunting	 Informing people about the negative sides of hunting and conservation of faunal diversity; Creating social barrier for people involving in hunting and poaching; CMC can help prohibiting people carrying any sort of traps, guns, baits and poison etc. 	
7	Lack of effective management	 Recruit and allocate sufficient skilled manpower for BFD; Train and motivate BFD staff to make them knowledgeable, dedicated and skilled for effective forest management; Give special attention for management of <i>C. pectinata</i> in the PA management programs. 	
8	Lack of mass awareness	 Distributing posters and installing billboards or signboards highlighting the forest resource management and conservation issues, i.e., <i>C. pectinata</i>, biodiversity, fire infestation, forest resource extraction, AIGA, eco-tourism etc. Conducting education and outreach activities on <i>C. pectinata</i> to the villages; Proving training and conducting periodic campaign on concurrent issues; Involve CMC, local government, social and religious leaders to aware local people; Recognizing the species as an important and valuable part of our heritage and environment; Local leaders from different social strata can be invited in different meetings, seminars and workshops on issues related to forest management, biodiversity conservation, threatened/native species conservation etc. 	
9	Lack of political will	 Nature loving political elites can be invited in BDNP who may motivate local politicians to help BFD local units for effective PA management; Local politicians should be given due respect by involving them in forest management activities and inviting them in relevant seminars and workshops; Local politicians can be made aware about the existing laws, rules and government policies regarding forest management and conservation. 	
10	Landslide	 Strict patrolling before the monsoon to prevent any practices that may promote landslide; Conducting plantations with site specific/local/native species after settlement of the collided soil in landslide regions; Identify hills (i.e., barren hills, hills with soil erosion) with prone of landslide and conduct afforestation or enrichment plantation. 	

resources including Cycas plant parts (e.g., leaves, fruit) are the major threats as mentioned by all the participants in FGDs (Figure 4). Cycads are of great ornamental value which makes people greedy to uproot young basal suckers, unscrupulously collect leaves and cones (Image 1) to sell in the market. Besides these, landslide and anthropogenic habitat destruction are two prominent threats that may cause significant damages to Cycas population in the future. Singh & Khuraijam (2010) also mentioned illegal trade and Cycas habitat destruction as two major threats responsible for depletion of its population in the wild of

Sikkim and West Bengal, India. Similar threats are also mentioned by researchers worldwide as contributing to reduction of Cycad populations (da Silva et al. 2014; Khuraijam & Singh 2015; Demiray et al. 2017).

Strengthening patrolling and enforcement of forest law through building capacity of BFD to implement the newly adopted managerial measures are the suggested means to be taken immediately for addressing threats. Moreover, raising mass awareness is a must for making the initiatives sustainable. Table 2 describes threatspecific measures.



Image 1. C. pectinata: A—adult Cycas with robust stem and dense leaves | B—mature Cycas | C—male cone | D—female sporophyll | E partial damage of Cycas by fire infestation | F—fire burnt Cycas | G—almost dead Cycas | H—cut Cycas. © Mohammed Kamal Hossain



Figure 4. Percent of people opined about the threats to *C. pectinata* in BNDP (Note: here, N= 55).

Need for conservation programs

Globally, cycads are threatened with many species at high risk of extinction. There was a common belief that the species is common across northeastern India, but it is actually mostly restricted to native habitats (Whitelock 2002; Lindstrom & Hill 2007). *C. pectinata* being the most wide spread cycad is now under threat as populations are declining rapidly compared to other Cycas (Khuraijam & Singh 2014), and the species is at the verge of extinction in northeastern India. The threats originate from anthropogenic interferences including agricultural expansion through destruction of wild populations, strip mining, collection of cones for medicinal uses, domestic & commercial development, and the trade of ornamental plants (Osborne 1995; Donaldson et al. 2003; Vovides et al. 2003).

Conservation of floral resources is a must for sustainable management of the natural resources of any country. Conservation is essential to maintain the existence of life on earth (Subrahmanyam & Sambamurty 2006). According to the World Summit on Sustainable Development (WSSD), CBD is the key instrument for the conservation and sustainable use of biological diversity. It also promotes fair and equitable share of benefits arising from the use of genetic resources. The conservation methods will, however, vary according to the specific objectives of conservation, and the distribution and biological nature of the material to be conserved. Conservation methods are often used to denote in situ conservation, ex situ conservation, ecosystem conservation, static conservation, selective conservation, conservation in use, and possibly more.

Conservation means of C. pectinata

A variety of conservation actions can be undertaken for threatened trees, each approach offering different merits. Not all approaches will be suitable for cycads, and the appropriate action will be dependent on the nature, distribution and habitat features of this species. Cycads are considered having a high conservation priority from both scientific and biodiversity point of view as they don't have very close living relatives (Norstog & Nicholls 1997; Donaldson 2003).

These plants have very specialized pollinators, and their re-establishment in nature is unlikely to be successful without a profound knowledge of their biology. Against this background, we firstly promote interest in, and appreciation of, these plants by propagating and growing them as horticultural subjects. Secondly, we actively encourage scientific research and the documentation thereof so that we can keep the captive and remaining wild plants alive in years to come.

The global status of Cycas pectinata as per IUCN Red List is 'Vulnerable' A2c due to an estimated 30% reduction in global population in past 90 years and a decline in the habitat quality (Nguyen 2010). In Bangladesh the species is not assessed yet as per IUCN Red List categories and criteria. An initiative is undertaken in 2020 by BFD under Sustainable Forest and Livelihoods (SUFAL) project to assess 1,000 plant species of Bangladesh including C. pectinata. (Singh & Khuraijam 2010) suggested to prohibit all international trade of this species by putting it in the Appendix I of CITES. In urban areas, C. pectinata are grown in gardens and private nurseries as ornamental plants, but in forest areas the species is not popular for plantation programs. Considering the rapid depletion of the population of Cycas, both in situ and ex situ conservation programs are proposed.

Further research to develop better germination techniques by studying germination behavior of the seeds and tissue culture to propagate the rare endangered cycads can be an effective way for mass production and germplasm preservation. There is also a need for ecological niche modelling and population viability analysis for *C. pectinata*. Interventions based on the lessons learned (i.e., awareness raising of the local villagers, studying ecology and environment, development of management techniques) from the cycad conservation projects (i.e., Debao Cycad Conservation Project) accomplished across the world might be helpful for undertaking the best actions.

To date no comprehensive conservation measures

have been taken for the protection of the species in Baroiyadhala National Park. According to Bangladesh Wildlife (Preservation), (Amendment) Act of 1974, any kind of killing, hunting or trapping of any wildlife, agricultural activities, living or entering in to the sanctuary of any persons or destruction to the sanctuary habitat are strictly prohibited. Finally, if a proper conservation plan is taken, it will be possible to protect and conserve the remnant *C. pectinata* populations in Baroiyadhala National park. It is our foremost responsibility to protect this native species along with bringing back the natural forests.

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সার সংক্ষেপ

১৯৩৮ সালে তৎকালীন বাংলার বারইয়াচালা প্রাকৃতিক বন থেকে সর্বপ্রথম উইলিয়াম গ্রিফিথ Cycas pectinata উদ্ভিদটি রেকর্ভ করেন। এই উদ্ভিদটির প্রাকৃতিক বিস্তৃতি বাংলাদেশের চট্টগ্রাম জেলার সীতাকৃত উপজেলার

বারইয়াচালার পাহাড়ি অঞ্চলে সীমাবদ্ধ। এই বনাঞ্চলটি ২০১০ সালে বারইয়াচালা জাতীয় উদ্যান হিসেবে ঘোষণা করা হলেও এর নিজস্ব (native) নগ্নবীজী উদ্ভিদের (*Cycas pectinata*) ক্রমাবনতি আশংকাজনক। এই গবেষণার লক্ষ্য ছিল বারইয়াচালা জাতীয় উদ্যানে *C. pectinata* উদ্ভিদটির সংখ্যা জানা, এই প্রজাতিটির গাছের

সংখ্যা কমে যাওয়ার কারণ অনুসন্ধান করা এবং নিজ প্রাকৃতিক আবাসস্থলে সংরক্ষণের (*in situ* conservation) জন্য এই উদ্ভিদটির সুনির্দিষ্ট অবস্থান জানা। ২০১৮ সালের এপ্রিল-জুন মাসে বারইয়াঢালা জাতীয় উদ্যানে দৈব

চয়নের ভিত্তিতে ১০০ মি × ১০০ মি আকারের ২১ টি নমুনা স্থান (sample plot) জরিপের জন্য ঠিক করা হয়। প্রত্যেক নমুনা স্থানে C. pectinata গাছের সংখ্যা, উচ্চতা, বেড় মাপার পাশাপাশি এই প্রজাতিটির প্রতি যত ধরনের হুমকি বা সমস্যা পরিশক্ষিত হয়েছিল তার সবই উপান্ত হিসেবে গিপিবদ্ধ করা হয়েছে। বনের সাথে স্থানীয় জনগণকে সম্পুক্ত করে চারটি আলোচনা সভা (Focus Group Discussion) করা হয়েছে। বনের সাথে স্থানীয় জনগণকে সম্পুক্ত করে চারটি আলোচনা সভা (Focus Group Discussion) করা হয়েছে। বনের সাথে স্থানীয় ফলাফল থেকে দেখা যায় যে, গবেষণা অঞ্চলে প্রতি হেক্টরে C. pectinata গাছ রয়েছে ১২ টি আর চারা আছে পাঁচটি তবে গবেখাছলের বিন্দ্রি স্থানে উল্লেখযোগ সংখ্যক মৃত ও বনের আগুনে পোড়া সাঁকসে গা ছরয়েছে। সাইকাস গাছের মনতু ও বিস্তারের উপর ভিত্তি করে গবেষণাস্থলে পাঁচটি সাইকাস হটস্পট নির্ধারণ করা হয়েছে যা উক্ত প্রজাতিটিকে তার নিজ আবাস্থলে সংবন্ধণে সহযোগিতা করবে। আবাস্থল ধ্বংল, নির্বিচারে বনে আগুন লাগানো, সাইকাসের পাতা, পুরুষ ও স্ত্রী পুষ্প মঞ্জী অতিরিক্ত হারে সংগ্রহ করার ফলে বনে এই প্রজাতিটির গাছের সংখ্যা দ্রুত কয় যায়ে। এই প্রজাতিটির সুরন্ধা ও পুনঙ্গেরেরে জন্যে নিকটের্ব হারায় মানুষদেরকে এই প্রজাতিটিকে গুরু বনো, সুরন্ধার মান্লা জ্যীতরেরণ গাছেরে বিন্দ্র অংশের ব্যবসা বন্ধকরণ ব এবং স্থানীয় মানুষদের এ আতিতিরি গুলতু বুঝানো, সুরন্ধার মান্দ্রা জ্যীতকরণ, গাছেরে বিন্দ্র অংশের ব্যবসা বন্ধকরণ বন্ধ এবং স্থানীয় মানুষের বনের উপর নির্কত্ত কযানোর জন্য টেকসই জীবিকার সুযোগ তেরি করা প্রয়োজন।

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