Detailed Final Report

Assessment of population, habitat and threats to *Cycas pectinata* Buch. -Ham, a vulnerable taxa in Bhutan.

Sonam Tobgay
Sherubtse College, kanglung
Royal University of Bhutan

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SUMMARY

Cycas pectinata is an important gymnosperm species which is now confined to the pockets of habitats in Indian subcontinents extended to parts of Southeast Asia. The species once widely distributed is declining due habitat destruction and loss and have been pushed to verge of extinction. Cycas pectinata is listed as vulnerable taxa in the threatened categorical lists of IUCN. Only one of the 117 extant Cycas species, i.e., Cycas pectinata.is found in Bhutan. In the biodiversity rich area, presence of Cycas pectinata is a relic to regional biodiversity possessing great scientific and conservation value because of its long evolutionary history. Although C. pectinata is well known from Southeast Asian countries, it is not studied in detail from Bhutan. This study has assessed population and threats to Cycas pectinata populations from two places in Bhutan. Field visits were made to study the habitat and associated threats to the population. Cycas pectinata were observed growing in steep rugged terrains in open chirpine forest. The populations are significantly threatened from human activities such as habitat destruction and ornamental collection. To certain extend populations are naturally threatened such as poor seed production due to low percentage of female plant and pest infestation.

INTRODUCTION

Cycas pectinata was first described by Scottish surgeon and botanist Buchanan-Hamilton in 1826 in the hill towards the eastern side of Bengal (Grierson & Long, 1983; Lindstrom & Hill, 2007; Nguyen, 2010; Khuraijam & Singh, 2015). *Cycas* is an evergreen, palm-like, dioecious tree with robust trunk (Grierson & Long 1983; Khuraijam & Singh 2015; Lindstrom & Hill 2007). *Cycas pectinata* plants are tall (1-12 m in height: 14-20 cm in diameter). The trunk bears an apical crown of pinnately compound leaves (Figure 2 A) with few spines in the petiolar region. Male plants bear large, cylindrical ovoid yellow or green male cones with numerous microsporophylls with long apical spines (Figure 2 B) (Khuraijam & Singh 2015; Lindstrom & Hill 2007). Female plants bear compacts closed cones with numerous broadly subulate pectinate megasporophylls which bear 2-6 ovules. Seeds are ovoid, glabrous, and orange to red-yellow colour in its mature state (Figure 2 C) (Grierson & Long, 1983; Lindstrom & Hill, 2007; Khuraijam & Singh, 2014, 2015).

Family Cycadaceae includes a sole genus *Cycas* with 117 accepted species (Calonje et al. 2019; Lindstrom & Hill, 2007). Cycads, a group which also include family Zamiaceae are one of the ancient gymnosperms whose origin dates back to at least the early Permian period, 280 million years ago, and possibly to the late Carboniferous period (300–325 MYA). Cycads are essentially "living fossils," or evolutionary relicts making it a great scientific and conservation value with their long evolutionary history (Zheng et al. 2017). The genetic information contained in cycads is important for paleontology, paleoclimatology, and paleogeography (Feng et al., 2016; Zheng et al., 2017). Additionally, cycads are thought to be the earliest gymnosperm lineage, reaching greatest diversity during the Jurassic-Cretaceous period, approximately 199.6 to 65.5 MYA (Feng et al. 2016). Cycads are bridges in major evolutionary transition in plants and remains indispensable for understanding the origin and subsequent evolution of seed plants (Feng et al. 2016; Zheng et al. 2017).

Cycyads once widely distributed are now primarily distributed in Africa, Asia, Australia, and South and Central America (Feng et al. 2016; Zheng et al. 2017). Current distribution of *Cycas pectinata* species extends from northern Burma to southern China (Lindstrom & Hill 2007; Nguyen 2010), generally recorded within the elevation range of 600 to 1,300m above sea level (Nguyen 2010; Khuraijam & Singh 2014), growth mostly restricted to subtropical and tropical regions. From Bhutan, *Cycas pectinata* was first documented by Grierson and Long (1983) from two districts: Mongar and Trashigang (Now Trashi Yangtse) growing at an elevation of 1100 meter above sea level. Subsequently four additional localities of the species are known (Tobgay et al. 2019), which none of these populations are studied in detail.

Cycads are the most ancient terrestrial plant, and its growth is mostly restricted to subtropical and tropical regions. Habitat ranges from closed canopy sub-tropical to grassland to semi-arid scrubland. Many species are restricted to particular substrates such as nutrient-poor soils, limestone or serpentine outcrops, dunes, and cliffs (Grierson & Long, 1983; Bhima, 2003; Lindstrom & Hill, 2007). Cycads grow in well-drained soils. Cycads have a pithy and starch-rich cortex and have specialized coralloid roots that contain symbiotic cyanobacteria. The cyanobacteria can fix atmospheric nitrogen, and this allows cycads to survive in nutrient-poor environments. Cycads are strictly dioecious plant and pollination is usually accomplished by wind or insects (Bhatnagar & Moitra, 1996; Watkinson & Powell, 1997; Ornduff, 2008; Zheng et al., 2017).

Cycas pectinata occurs in medium to the tall, closed forest on deep, often clay-rich and more fertile soils or steep rocky slopes, usually as part of the general shrub understorey in moderate to deep shade (Grierson & Long, 1983; Lindstrom & Hill, 2007; Nguyen, 2010). It is recorded from a variety of substrates, but most frequently occurs on clay soils over limestone. Climate is tropical with wet, humid summers and milder, drier winters. Although often found on limestone substrates, it is by no means restricted to these, and it also occurs on granites and meta-sediments (Lindstrom & Hill, 2007; Nguyen, 2010).

Known habitat of *C pectinata* from Bhutan are mostly confined to small populations of geographically isolated and rugged terrain of river gorges likely posing threats of genetic viability in the future (Yang et al. 1996). Although more than half of the Bhutan's total land area is protected for conservation (Wildlife Conservation Division 2016), only one known location of the *C. pectinata* is in the protected area, making the species less likely to get protected by law with priority. Habitat suitability modeling under climate change scenario also does not indicate the protection of the species from the known location (Pradhan & Chettri, 2017). Conservation of some important species like *C. pectinata* are threatened by developmental activities like construction of new and widening of existing roads, building dams, hydropower projects and electric transmission lines. All the known localities of the taxa are all in banks of big rivers, which are all used for hydropower projects. Such activities increase threats not only through habitat destruction but exploitation through collection for ornamental value and for food by increasing population in the localities. In Bhutan, despite the mention of the locality of *Cycas pectinata*, the detailed study on its population has not been documented. Although 68 globally threatened floral and faunal species are legally protected in Bhutan, *Cycas pectinata* is not included in the list (Biodiversity Statistics of Bhutan 2017).

Today cycads are by far the greatest threatened plants on the earth (Donaldson 2003; Zheng et al. 2017). Around 62% of Cycads are listed in IUCN as threatened group of plants (Nagalingum et al. 2011). *C. pectinata* though considered as one of the most common and widespread cycads, currently its population is decreasing due to habitat loss. The IUCN estimates around 200,000-250000 individuals of *Cycas pectinata* in the world and is listed vulnerable in the threatened categorical lists of IUCN (Nguyen, 2010). The species is under severe threat with its population declining due to estimated 30% of its natural habitat destroyed over past 90 years (Pradhan & Chettri 2017). More of its suitable habitat are likely to get reduced under predicted climate change scenario (Pradhan & Chettri, 2007; IPCC 2007).

Important threats to Cycads in general are collection from wild for various purposes across the globe. *Cycas* has probably been used by people since prehistoric times in some parts of the region and they have been traded for many different purposes (Bhima, 2003; Donaldson, 2003). The most common uses have been for food, medicine, and culture practice. For example, In North Indian states including Manipur, Sikkim, West Bengal, Assam, and Meghalaya, soft and tender leaves of *Cycas pectinata* are used as green vegetables and to prepare local cuisines such as Yendang Eromba and Yendang Kanghou. Starch-rich stems and fruits are eaten either raw or roasted like potatoes. The fleshy stem is pounded and also used as hair wash by tribal people in Assam (Nguyen 2010; Khuraijam & Singh, 2015). Leaves are used for ceremonies, decoration, and weaving baskets. Stems, roots, barks, male and female cones are used for medicine as well as for cultural significance (Khuraijam & Singh, 2015). Indigenous people of Northeast India have used *Cycas* plant parts to cure asthma, cystolithiasis, and stomach ache, and to be traded for proprietary drugs available in the market (Nguyen, 2010; Bhowmik & Datta, 2014). *Cycas* also has a long history of use as ornamental plants in Asia and they have recently become popular garden and collector plants in other parts of the world. Today, by far the greatest global trade in *Cycas* is as ornamental plants, with more than 30 million plants being traded between 1977 and 2001 (Bhima, 2003). *Cycas* have been used as ornamentals for a long time in several parts of Asia and they are highly valued in Chinese and Japanese cultures (Bhima, 2003). *Cycas* revoluta has been the widely used species although other species of *Cycas* have been used in many places (Bhima, 2003).

METHODS

Study site

Bhutan is a part of Eastern Himalayan global biodiversity hotspots known for species richness with more than 11,000 known species (National Biodiversity Centre 2019). The great variation in climatic conditions across the small geographic area has supported diverse biodiversity in Bhutan. The IUCN (2019) has listed 99 species from Bhutan as globally threatened species including 43 plant species, of which 13 species are Vulnerable to extinction including *C. pectinata*. This study has assessed population, habitat and immediate threats and conservation measure of C. pectinata from two known locations from Bhutan: Trashiyangtse and Mongar. In Trashiyangste, the population of *C. pectinata* grows on the Eastern bank of Dangme Chhu opposite Gomphu Kora in Ramjar under Trashiyangtse district. The place name is called "Bawoong shing-pek" meaning the hill of *Cycas pectinata*. Other popualtion of *C.*

pectinata was assessed from Lingmethang and Kurizampa in Mongar district. Both historical and current popualtion in this site lies on the bank of Kurichuu (Figure 1). Population here is easily aaceesible with national highway passing by the area. Threes locations within the locality has been assessed for this project. The vegetation in both the study area is mostly dominated by large chirpine trees (*Pinus roxburghii*) forming canopy and lemongrass (*Cymbopogan flexuosus*) forming dominant ground vegetation (Table 1). Other commonly associated shrubs include *Rhus paniculata, Phylanthus emblica, Ficus bengalensis Asparagus racemosus* (wild asparagus), *Xanthoxylum* sp. and *Gerwia* sp. Other associated ground vegetation includes, *Artemisia vulgaris* and *Chromolena odorata.* Ramjar study site is steep with hilly terrain and rocky outcrops while in Kurizampa the study site was on hilltop.

Data collection

Population assessment in the Ramjar locality was carried out by laying random quadrate within approximately 1.5 sq.km between elevation range of 787 and 1394 masl. The sampling could not be done uniformly as proposed due to completely inaccessible areas of the study site. However, the presence of the species in the habitat demarcation has been confirm through visual inspection from other side of the river Damgmechu. A total of 20 quadrate measuring 40m^2 were laid. However, in Kurizampa all the individual plants in the study site were counted considering very small population. All the *C. pectinata* plant within the quadrate and in the study, area was counted, and morphometric measurements were taken along with geocode for the quadrate. Male and female plants were noted based on the type of cone they bear if any. Each plant was measured for their height and girth at the base. Plants with well-formed above ground stem measuring >5cm were recorded as established individuals and plant with less than two leaves and stem not seen above ground were categorized as seedlings. Total leaf on each plant counted along with measurement for length of selected leaves from each tree. Leaf sample was collected from each tree and number of pinnae counted along with length of petiole measurement. Those small plants with height less than 5 cm were categorized as seedlings. All the quadrates and site of the population was assessed for any signs of threats by noting possible signs such as yellowing of pinnule, pest infestation, sign of leaf being nibbled and other damages to the plant/parts of plants and seeds.

Population structure determination

The cycad plants do not have annual growth ring which are generally used to estimate the age of the trees. For this population age structure of the plant is determined by the height of the plant which are significantly related as seen in other *Cycas* species by Jian et al. (2006).

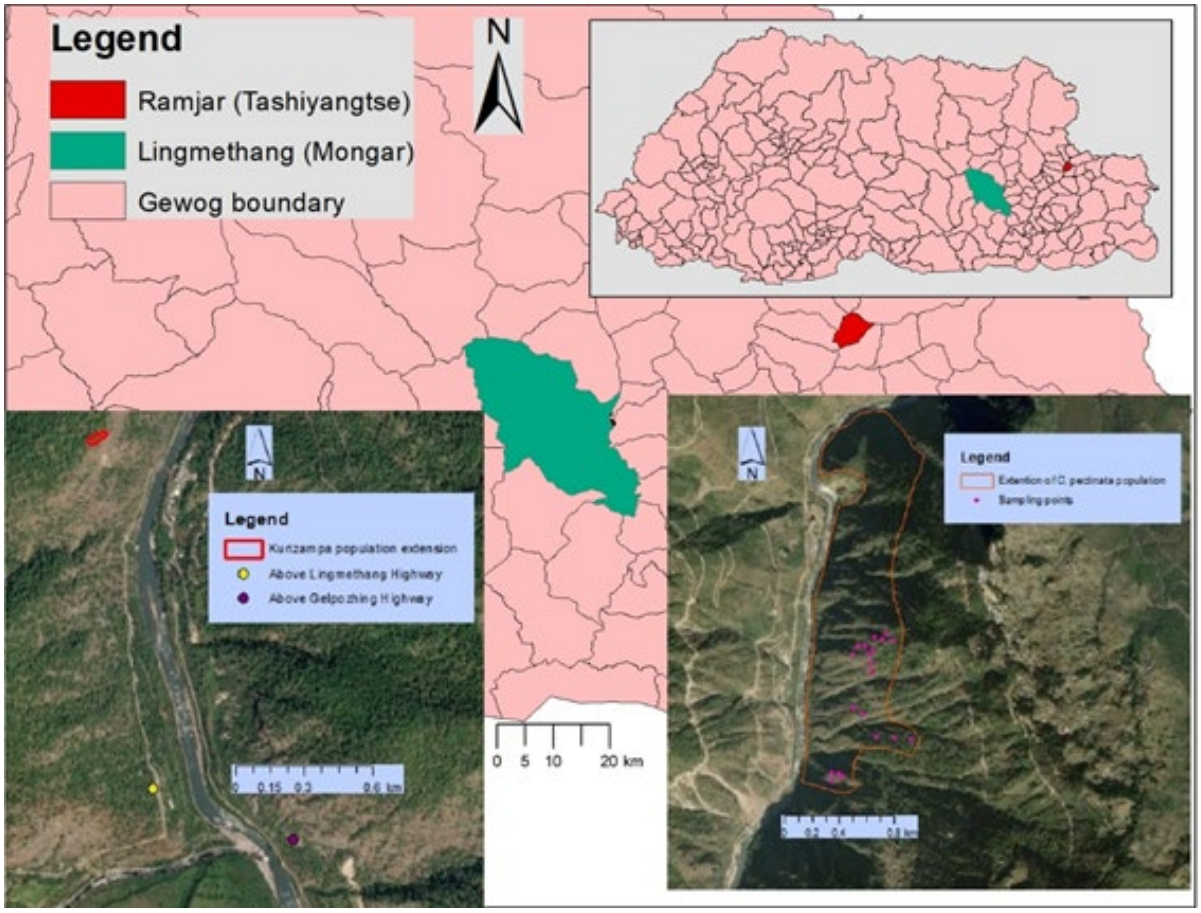


Figure 1. Study site

Awareness and education programme

The findings of the study were communicated through presentation in schools and institutes through presentation, interactive question answer sessions and brochure (Figure 6). A survey was conducted amongst targeted school students on the knowledge of the species: two groups of students from two schools in proximity of the *Cycas pectinata* populations, i.e., Ramjar and Lingmethang Middle Secondary School. However general public awareness could not be carried out for covid-19 pandemic protocol reasons, where large public gatherings were prohibited. However, students were requested to be an ambassador and share the knowledge and information gained through presentation regarding the species to their parents at home.

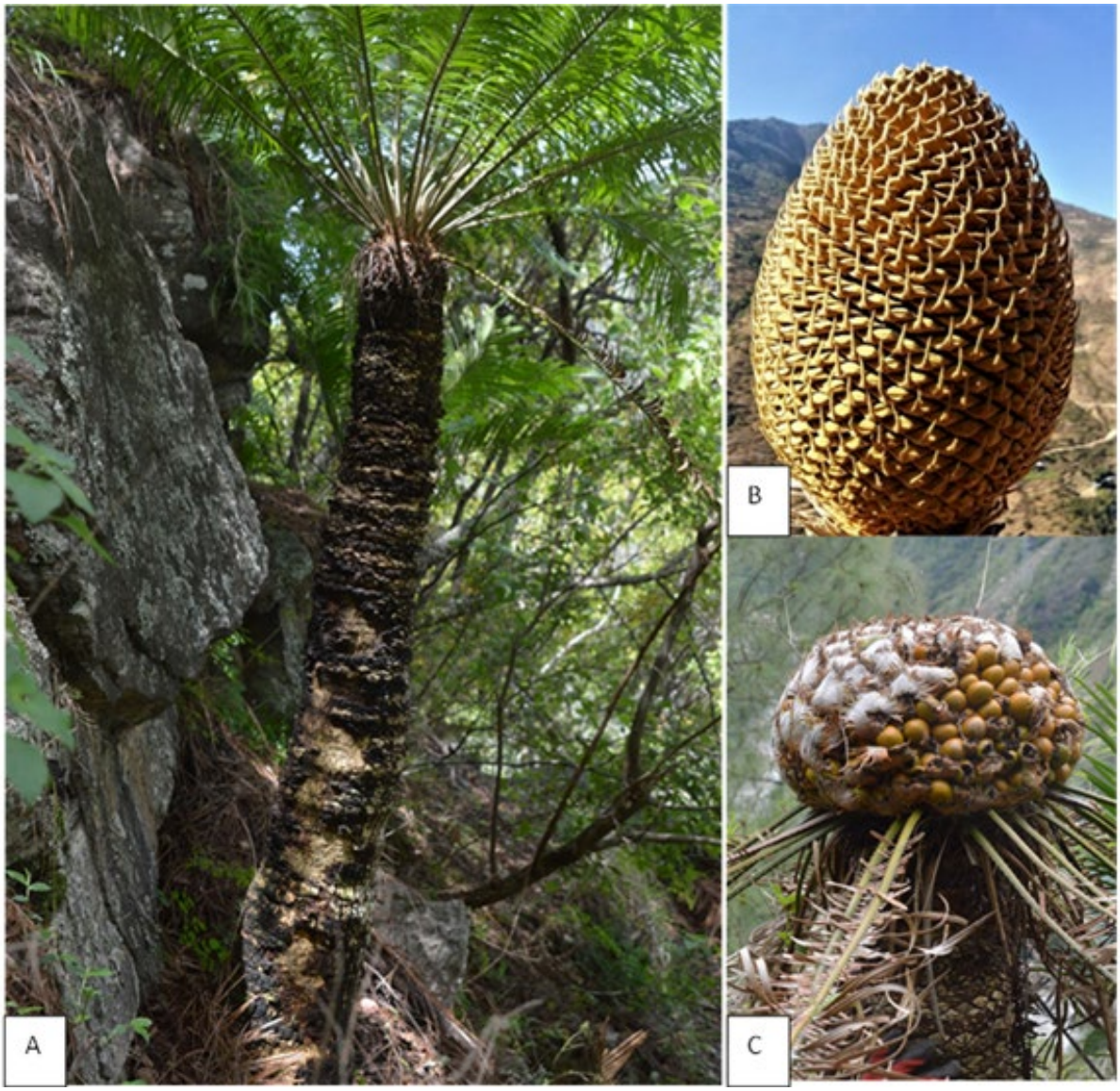


Figure 2. A-Adult cycas pectinate in a nature population showing robust trunk with crown of pinnately compound leaves, B-Matured male cone and C-Mature female cone with seeds formed.

RESULTS

Population structure

From the study site in Ramjar, Trashiyangtse, a total of 566 individual plants were counted. Of these 25 were with female cone and 43 with male cone and remaining without any types of cones during the time of field sampling, thus could not determine their sex. Most of the female plants recorded were with fully formed matured ovules and male plants were with remnants of male cones as well. In this population shortest male cone bearing plant measured around 50 cm and female cone bearing plant measured 55 cm.

An average density of plants measuring more than 5cm of stem height within quadrate was 27 (SD= ± 13.42). In an estimated 1.5 square km of *C. pectinata* habitat, total number of plants is estimated to be around 25000 individual plants. The distribution of

plants shows significant relationship with elevation (p value 0.045 and R^2 =0.51), increasing density towards lower elevation gradient.

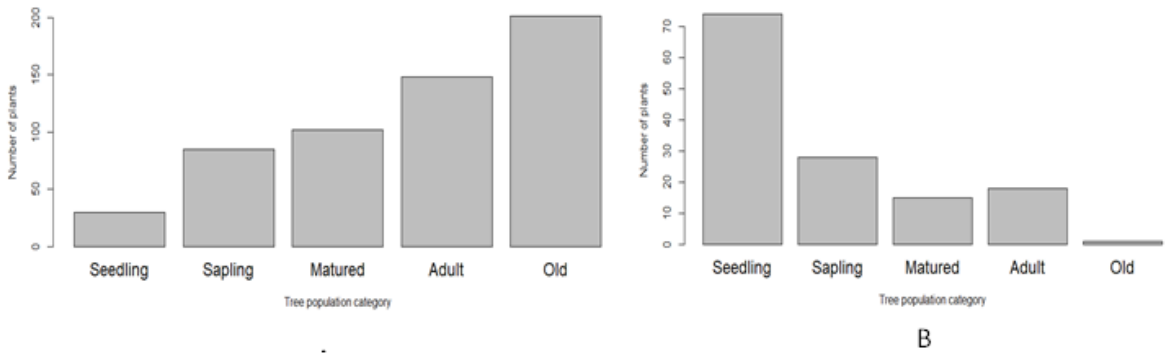


Figure 3. Population structure of Cycas pectinate plant from A-Ramajar in Trashiyangste and B-Kurizmapa in Mongar.

In Lingmethang (Mongar) study area, three different populations were identified. An entire population of *C. pectinata* in Kurizampa comprises of 62 established individuals - stem height measuring >5cm, and 74 saplings. Of these three plants were with female cone and seven were with male cone. Male cone bearing height was minimum of 80 cm and 56 cm for female plant. Other sites in the region which includes an area above Lingmethang highway had recorded only one male plant, and other site above Gelpozhing highway recorded three individuals all without any sign of coning. Age classification of individual plants measured in the field shows *Cycas pectinata* population has an opposite pyramid age structure in Ramjar site (Figure 3 A). There are more older plants but fewer younger ones in contrast to population from Kurizampa with more young individuals compared to older plants (Figure 3 B).

Conning and regeneration

In both the population number of plants bearing cones are very low compared to the total number of adult and old individuals which all have the potential of bearing one kind of cones. Further, the percent of plants bearing female cone are lower than the male cone bearing plant. Population in Ramjar site have 2% and 11.75% of female and male conning individuals respectively. In Kurizampa population have 15.79% and 31.58% of the adult bearing female and male one respectively. (Table 1). Regeneration from bulbils are common in *Cycas* species in addition to regeneration from seeds (Figure 4 B). A total of 36 individuals were recorded with a total of 105 bulbils, mostly associated with fallen trunk remains (Figure 4 A). Only one fallen trunk base was recorded with 3 bulbils in Kurizampa site.

Table 1. Location and characteristics of *Cycas pectinata* habitat

Site name	Latitude	Longitude	Elevation range (masl)	Habitat	Area (m2)
Ramjar	27.417	91.56827	791-1296	Open chirpine forest and broad leave forest with lemon grass	1514856

Kurizampa	27.276	91.19106	844-872	Open chirpine forest with lemon grass and *Chromolena odorata*	2285
Lingmethang Highway	27.263	91.19059	641	Open chirpine forest and lemongrass	
Gelposhing Highway	27.26	91.19595	597	Open chirpine forest with rocky areas	

Threats to the population: anthropogenic

Socio-economic developmental activities are common in both the regions of Ramjar and Kurizampa but possess different level of threats to different populations. In Ramjar site, these activities do not possess eminent threat to *Cycas* population in the area. Activities for hydropower project on the other side of the river, Dangmechu are completely cut off by the river. Other activities like road construction was away from the area where *Cycas* plant was recorded. However, in Lingmethang areas *Cycas pectinata* population are directly associated with modern socio-economic development activities. This includes more human settlement, construction and widening of roads and other hydropower related activities. The site above Lingmethang Highway and Gelpozhing Highway were represented by only one and three plants respectively. Small population above Kurizampa were observed to be frequent by cattle and occasionally by human.

Threats to the population: natural

Plants in both the population were recorded with symptoms of pest infection. Leaves with infestation were observed with drying or cut off pinules on rachis. Trees from Ramjar site were commonly observed with young leaf rachis bored by larva (belonging to Lipidoptera) resulting in crown of young leaves die (Figure 5 A & B).

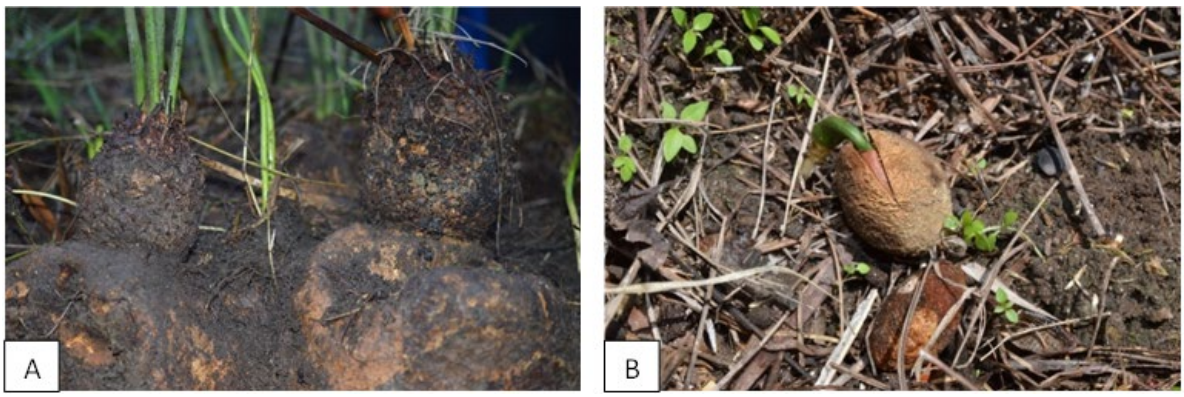


Figure 4. Sprout of young stem developing from bulbils (A) and seed germination (B)

Additionally, litter collection in the crown of leave bases have been observed to have inhabited by millipede resulting in deformation of new young leaf sprouts (Figure 5 C & D). Wild boars as well are seen as threat to the sustainability of *Cycas* population in Ramjar site. Wild boars have moved into the area in last decade only, as communicated by the locals. Common observation of seeds being damaged with bite marks and young plants uprooted were made in the area (Figure 5 G &H), but not observed in population from Kurizampa and nearby areas. Adult plants are resistant

to fire incidences protected by thick scaly bark. But such frequent disturbances have resulted in distribution and growth of invasive plants species. This was evident in Kurizampa area where plants were outcompeted by weed species like *Chromolana odorata* (Figure 5 I & J) for light and space.

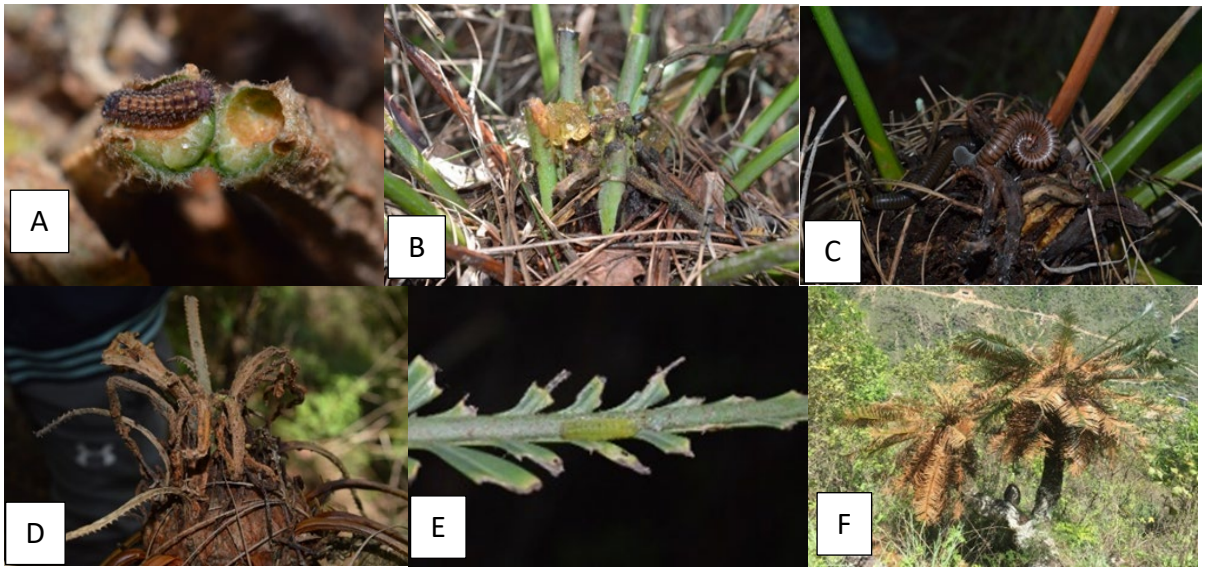
Table 2. Age structure of the two natural population of *Cycas pectinata*

Site	Ramjar			Kurizampa		
Tree Height Class (Stem height)	No. of plants	Cone		No. of plants	Cone	
		Male	Female		Male	Female
> 100 cm	201	32	19	1	1	0
51 cm - 100 cm	148	9	7	18	5	3
26 cm - 50 cm	102	0	0	15	0	0
6 cm - 25 cm	85	0	0	28	0	0
< 5 cm	30	0	0	74	0	0

Table 3. Level of threats as determined by the characteristics of the leaves

Leaf characteristics	Kurizampa	Ramjar
Pest	62 (100%)	158 (62.69%)
Few leaves, not integrated	13	93
Many leaves, some integrated	2	55
Many leaves, integrated	45	64
Nibble	7	22

Human collection of the plant specimen were not evident in Ramjar site, except one of two planted nearby their house. In contrast plants in Lingmethang areas are greatly threatened by human collection. Locals familiar with the places confirmed presence of more *Cycas* plant above Gelpozhing Highway a couple of years back. But during this study visit, only small three individuals were recorded, and rest were all collected for ornamental values.



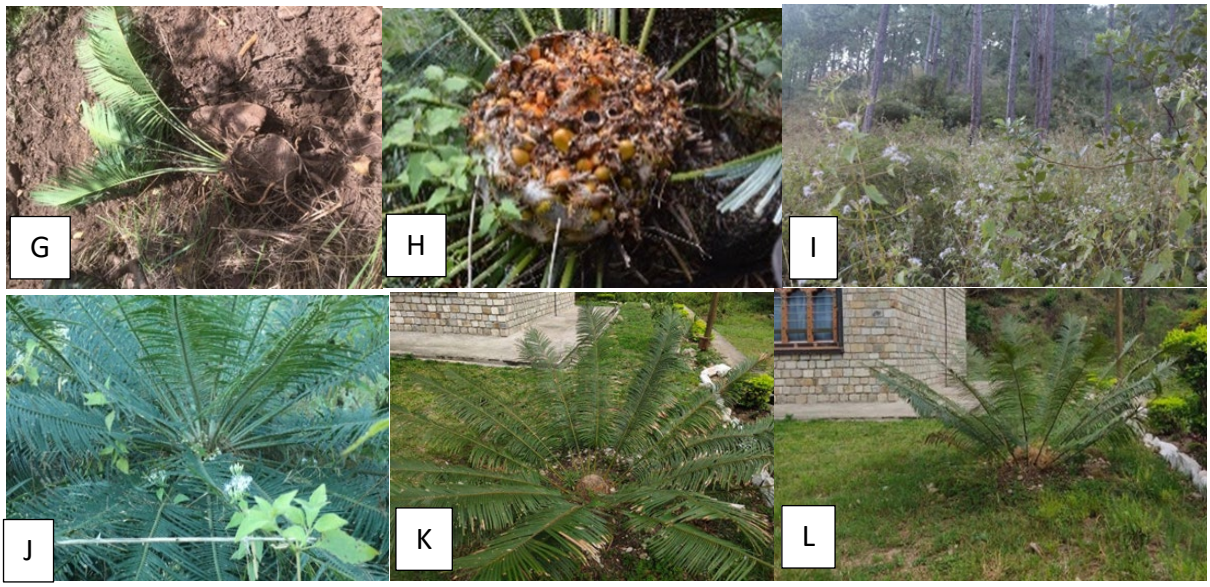


Figure 5: A &B Young leaves bored and eaten by larva (Lepidoptera). C & D Millipede inhabiting at the bases of corwon of leaves. E Remnants of leaf pinnule. F Leave showing symptoms of gradual drying of leaves. G Small plants uprooted by boars. H Female cone with seed formed being damaged by boar. I & J Extensive growth of *Chromolana odorata* in the habitat. K & L *Cycas pectinata* planted as ornamental plant.

Figure 6. Brochure used for awareness education to students and locals

Figure 7. Presentation made to three cohorts of students. A & B- Findings from these projects made during Second Annual College Research Seminar (ACRS 2) on 2-3 September 2021, at Sherubtse College. Education awareness to students of Ramjar Middle Secondary School C & D, and to Lingmethang Middle Secondary School E, F & G.

Awareness and education programme

A total of 72 students, 38 female and 31 males, from two schools located in the proximity of the *Cycas pectinata* population attended the presentation and completed survey questionnaire (Figure 7). From the total student participants, 58.3% knew the *Cycas pectinata* plant and 41.7% had no idea of the plant. Only 21.9% from Ramjar School responded to have known the plant in oppose to 67.7% of students from Lingmethang School knew the plant. Students from Lingmethang have seen the plant planted in one of the institutes near school. No participants, except for one knew the local name and any cultural significance of the plant.

The presentation on the species could change the view of students on plant, particularly the conservation aspects. All students participated agreed to importance of saving the species. The importance were highlighted by 59.7% students being convenience through presentation, that the plant is vulnerable, while 22.2% shared the importance of plant in ecosystem and biodiversity. Emphasizing on the importance of the plant, participants agreed to help protect the species, 59.7% believing creating awareness amongst population being seen as one of the important measures to protect such species. Environmental protection (18.1%) including avoiding forest fire (15.3) were other suggested measure that could be taken to save the species in their natural population.

Only 20 parents have responded to the survey questionnaire from more than 72 anticipated. *Cycas pectinata* plants were known to 85% of the respondent, 52.9% knew the local name (‘Bango shing’) and 47.1% were knew the cultural significance of the plant. Half of the parent respondent believing the plant is rare. The concern highlighted is reflected in willing to protect the species in their natural population through environmental protection including preventing forest fire. Others believed planting as ornamental plant would be alternative measure to save the species, further adding to creating awareness amongst other population.

DISCUSSION

Population structure of Cycas pectinata

Grouping plants by height approximating their age, *Cycas pectinata* population in Ramjar site has an opposite pyramid age structure. Number of individuals are more in the adult and old categories, compared to number of saplings and seed recruitment in the area. Similar declining recruitment of seedlings are observed in population of other *Cycas* species (James et al. 2018). Low seedling recruitment directly threatens the viability of the population as the fewer individuals would replace old plants, which over a long term can reduce the number of plants in the population (Dian-pei et al. 2012; Shen et al. 2009). In contrast population from Kurizampa had more of sampling recruitments than older plants, a positive look for sustainability of the population in the area. However, the number of individuals in the different populations would greatly contribute to the viability of the population. Only 62 adult plants constitute a population in Kurizampa.

A population from Ramjar site was observed with increasing density of plants in lower elevation and density decreases as the elevation increases. However, this relation from Pearson correlation test indicates a weak association $P > 0.05$. ($r = -0.73$). The increasing density on the lower elevation can be associated with the steepness of the

habitat and larger size seeds, which coupled would facilitate easy roll down along gravity thus concentrating seed germination in lower elevation. Other mode of seed dispersion was as well evident in the field. Seedling recruitment in higher elevation ranges above the adult tree affirms that seeds dispersion was mediated by small mammals like rodents and fruit eating bats (Dehgan & Yuen 1983; Yang & Meerow 1996).

Coning and regeneration

Stability of the population would be determined by the number of seed producing individuals in each population. In both the populations there are fewer coning individuals, particularly female. Only 2% and 15.79% of adult population beard female cone compared to 11.75% and 31.58% of adult plant bearing male cone, in respective population from Ramjar and Kurizampa. The trend of declining coning individuals are common in population of other *Cycas* species as well (Jian, et al, 2006). Determination of sex composition of a population is important, particularly for dioecious plant like *Cycas* to understand population stability. Many works of literature support a 1:1 ratio as a theoretical and evolutionarily stable sex ratio for maintaining a dynamic population under natural selection (Shin et al. 2019; Tarsi & Tuff 2012; Yu & Lu 2011). Without comparable numbers of males and females, reproduction opportunities may be limited, and population growth stunted (Tarsi & Tuff, 2012). Similar observation of dwindling sex ratio in cycad populations have been made resulting in reduction of seed production and maintenance of the population size (Singh & Singh 2010). Nonetheless, Ueno et al. (2007) claims that in most dioecious plants, either the population sex ratios do not depart from unity, as expected by Fisher's law (Fisher 1930), or males are more numerous than females, same as observed in this study. This difference is attributed to higher reproductive cost for female requiring producing seeds, resulting in reduced growth rates, higher mortality rates, delayed flowering, lower frequency of future reproduction, and less extensive clonal growth. The ultimate of the lesser seed producing individual means low number of recruitments and population in decreasing trend.

Threats to the population

Human activities and habitat destruction continues to be the major threat to the species diversity including loss of plant from wild (Hossain et al. 2021; Zheng et al. 2017). Historical information confirms *Cycas pectinata* population in the area above Lingmethang Highway thriving very well which now is found to be represented with only single male plant. The *Cycas* population was very much thriving some 10-15 years ago in the area above Lingmethang Highway, as locals would recall. Threats to the *Cycas* population in the area is clearly from human population and developmental activities. Population re-settlement driven by developmental activities and associated economic activities in the area are worth noting to have contributed to loss of population. Activities such as road widening, establishments of gravel grinding machineries and tunnel construction for hydropower plant have contributed to direct habitat loss resulting in loss of plant from the area.

Loss of *Cycas* plant population from one of the study sites near Gyelpozhing Highway is a very recent event. The loss of plant from this location can be evidently attributed to human collection of the specimen for ornamental value. The area being easily accessible through roads, collections have been facilitated from the area. Locals have collected the specimen to be planted as ornamental plant, a common threat to Cycas

(Bhima 2003; Chowdhury et al 2011,) beside being culturally associated in using as sources of nutrition (Hossain et al. 2021; Khuraijam & Sing, 2015).

Awareness and education programme

The education and awareness are some of the key measures to save the species (Morara & Peterliceana, 2012; Ramadoss & Moli, 2011; Chowdhury et al. 2011) and for the same reason part of this project was focused on creating awareness and educating students and other local people. The importance and responsibility to save the species is reflected by all the participants including parents agreeing to the need of saving species in their natural population after presentation, in oppose to only little more than half of the participants knowing the plant before presentation. Emphasis on protecting environment is greatly heightened by organization and individuals intended to protect species (Ervin et al. 2010). The participants reached to through this project as well agrees to environmental protection (18.1%) including protecting from forest fire (15.3%) being a way of saving the species, in particular the threatened taxa.

Although parents to participating students (85%) knew about the plant, including local name (52.9%) – 'Bango shing'. Despite students coming from the nearby places where the *C. pectinata* plants grow, only 58.3% of students knew about the plant, that too having seen as planted for ornamental value and not in their natural population. Further only one student knew local name which otherwise many of their parents (47.1%) knew. This project has helped to narrow the information gap between the generations, creating awareness, an effective tool to conserving species (Morara, & Peterliceana, 2012). Excepting for one student, other younger generation didn't know of any cultural significance of the plant growing in their region. Otherwise, elder generations at least knew stories about using the plant in their own way like in other regions (Khuraijam & Sing, 2015; Bhowmik & Datta, 2014; Bhima, 2003). However, this study affirms the plant has been not used for any cultural practices despite knowing the use. Elder generation narrated stories regarding possible economic benefits that could derived from the *C. pectinata* plant. Ancestors have the messages passed down through generations that in times of famine, local can resort to plant as a source of food supply. They believe the seeds and trunk, after removing outer cover, can be dried, pounded to flour and use as a source of nutrition. Local also do share in the earlier days, the starch rich pith of the trunk was used as baits for fishing.

CONCLUSION

It is very clear from the study elsewhere and this study that old lineage plant populations are much more threatened and requires priority conservation plans. As anthropogenic activities continue to be a major threat, education and awareness are some of the possible ways to conserve and save species in their natural population. The younger generation in our community requires education not only in the school but parents could as well play a significant role in creating awareness of the existence of the species in the locality.

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