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Research Article

Flowering Calendar of the Macrophytes of Keibul Lamjao National Park, Loktak Lake, Manipur, India

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Abstract

Background and Objective: Flowering calendar of a particular area will give the information of the period and duration of flowering among plants. The purpose of the study is to investigate the presence of the habitat of some dominant macrophytes in Keibul Lamjao National Park (a Ramsar site) which have ethnobotanical relationships with human beings (the lake dwellers in particular and tourist in general) and wild animals. **Materials and Methods:** Flowering calendar of 6 study sites viz., Keibul, Nongmaikhong, Kumbi, Khordak, Sargam and Toyaching were studied and monthly flowering calendars were taken for 2 years period (2010-2011). Flowering calendars of the macrophytes were surveyed by following standard methodologies and comparison of the stages of flowering period of 6 study sites was incorporated. **Results:** Maximum number of flowering plants was recorded in Sargam (44), Khordak (32), Kumbi (30) and Nongmaikhong (29) during the period September-November. Whereas, Toyaching reached 35, Keibul recorded lowest plant numbers 14 during the period June-August. Four plant species viz., *Ageratum conyzoides*, *Alternanthera philoxeroides*, *Leersia hexandra* and *Hedychium coronarium* were found throughout the year in all the 6 sites. **Conclusion:** From the findings, it can be concluded that flowering calendar will give the information of plants which are used as fodder for the wild animals like sangai (*Rucervus eldii eldii* McClelland) an endangered deer species in this globe and ethnobotanically important plants of the lake dwellers as food, medicinal plants and allergens, thereby maintaining health status of man and animals. Conservation is required by controlling the human anthropogenic harassments, thereby maintaining the luxuriant growth of the seasonal and perennial, macrophytes observed during the study of flowering calendar, so as to maintain and conserve the natural flora and fauna of the park.

Key words: Keibul Lamjao National Park, Ramsar site macrophytes, aquatic environment, flowering calendar, ethnobotanical relationships with human beings, information of plants, fodder, food, maintaining health status of man and animals, conservation

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Flowering calendar of particular vegetation is to know the seasonal availability of the angiospermic plants for different purposes may be used by aerobiologists to predict and examine the available pollen flora giving emphasis on allergenic pollens of grasses in Srinagar, Kashmir Himalaya (India) for health by Munshi¹. He further reported that several grass pollens are important environmental bio-pollutants, causing various allergic disorders in susceptible persons. Therefore, it is essential to study the period and duration of the flowering of the plants growing in a particular area. It is mandatory to know the exact period of flowering among plants along with their correct nomenclature. In India, especially in tropical climates, some research work has been carried out on compiling the flowering calendar²⁻⁷.

For Manipur state a group of researchers investigated the flowering calendars of different localities related to allergenic pollens⁸⁻¹¹. The seasonal availability of the macrophytes of Keibul Lamjao National Park (KLNP), Loktak lake, Manipur was studied by Devi *et al.*^{12,13}, however, so far no report on the flowering calendar of the lake.

Loktak lake (a Ramsar site) is the largest lake in Manipur covers an area of 286 km². It is situated 38 km South of the capital city (Imphal) of Manipur state (Fig. 1, 2). Loktak lake is almost oval-shaped and length and breadth calculating maximum during rainy season attains 26 and 13 km, respectively with an elevation of 768.5 m above the mean sea level. It is a eutrophic natural fresh water lake and the biggest lake in the North Eastern India. During lean season the lake is very shallow ranges from 0.5-1.5 m and total water spread reached about 490 km² during rainy season¹⁴. From the isotopic data of the Loktak lake sediments suggest that the lake is about 25,000 years old i.e., the middle of the last glacial period¹⁵. The origin and evolution of the lake may be ascribed to tectonic activity and neotectonism remarkably influenced by a long history of fluviolacustral process¹⁶.

Keibul Lamjao National Park (KLNP) is a natural and floating park inside the Loktak lake 40 km² in area and the only floating mat in the world (Fig. 1, 2). The area is engaged for conservation of *sangai* (*Rucervus eldii eldii* McClelland) an endangered deer species. Macrophytes of KLNP are the specific and dominate wetland, shallow lakes and streams. Macroscopic flora includes the aquatic angiosperms (flowering plants), pteridophytes (ferns) and bryophytes (mosses, hornworts and liverworts). These are growing in luxuriant growth in the park, these plants are growing above the phumdi. The park supports macrophytes and wetland vegetation. The park's phumdi is very rich in plant diversity.

About 48 species of plants have been recorded in the park by Singh and Singh¹⁶, ethnobotanically uses of 24 plants on the phumdi of Loktak lake was recorded by Singh¹⁷, 145 species of plants also by Singh¹⁸ and Deb^{19,20} listed 125 species, Sinha^{21,22} recorded 157 species of wet land species and Trisal and Manihar²³ described 132 plant species in KLNP. Floating plants are the primary plants involved in the formation of the phumdi. It had the association of plants species from different groups and families. These plants are very useful as food (Wild edible), fuel, medicine, fodder and fencing and also for many other purposes by Devi *et al.*^{12,13,24}.

From the above mentioned facts it is necessary to study out the flowering calendar of the macrophytes of KLNP with significant statements:

- Macrophytes of KLNP play a very important role as ethnobotanically important plants
- To examine the availability of macrophytes in various seasons has a close relationship with the health status of human beings (Wild edible food plants, medicinal plants, precaution of allergenic pollen producing plants) and fodder for the wild animals like *sangai* (*Rucervus eldii eldii* McClelland) an endangered deer species in this globe and migratory and endemic birds as their food
- If the dominant macrophytes are disturbed by human anthropogenic activities, the natural habitat of *sangai* will be disturbed leading to extinction and the only floating mat Phumdi aquatic environment will be no more
- Conservation is required with help from governments, public, NGOs by controlling various activities, thereby maintaining the luxuriant growth of the seasonal and perennial, macrophytes observed during the study of flowering calendar, so as to maintain and conserve the natural flora and fauna of the park

MATERIALS AND METHODS

In Manipur state there are generally four seasons namely, winter (November, December and January), spring or monsoon (January, March and April), rainy season (May, June and July) and summer (August, September and October). However, to know the floristic composition of the angiospermic plants, we need to collect information throughout the year in each and every month. Six study sites at KLNP Loktak lake Manipur is situated between 24°27'N and 24°31'N latitude and 93°53'E and 93°55'E longitude. Six study sites of KLNP, namely: Keibul, Nongmaikhong, Kumbi, Khordak, Sargam and Toyaching were identified for the purpose of recording the flowering periods of different species of plants during 2010-2011 (Fig. 1, 2).

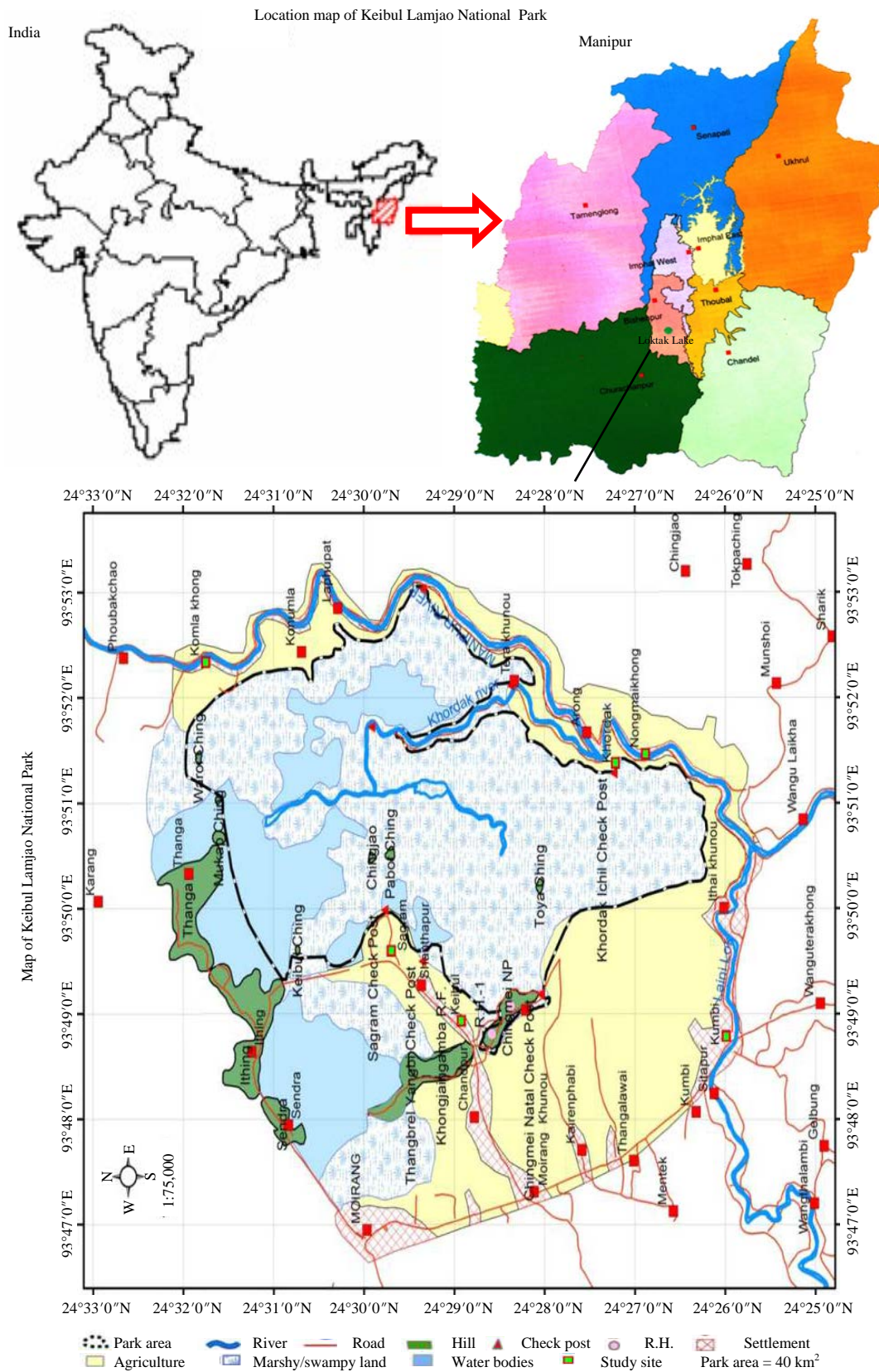


Fig. 1: Map showing the location of study site in the Indian sub-continent, Manipur state, Loktak lake in Bishnupur district and Keibul Lamjao National Park (KLNP), Loktak lake, Manipur

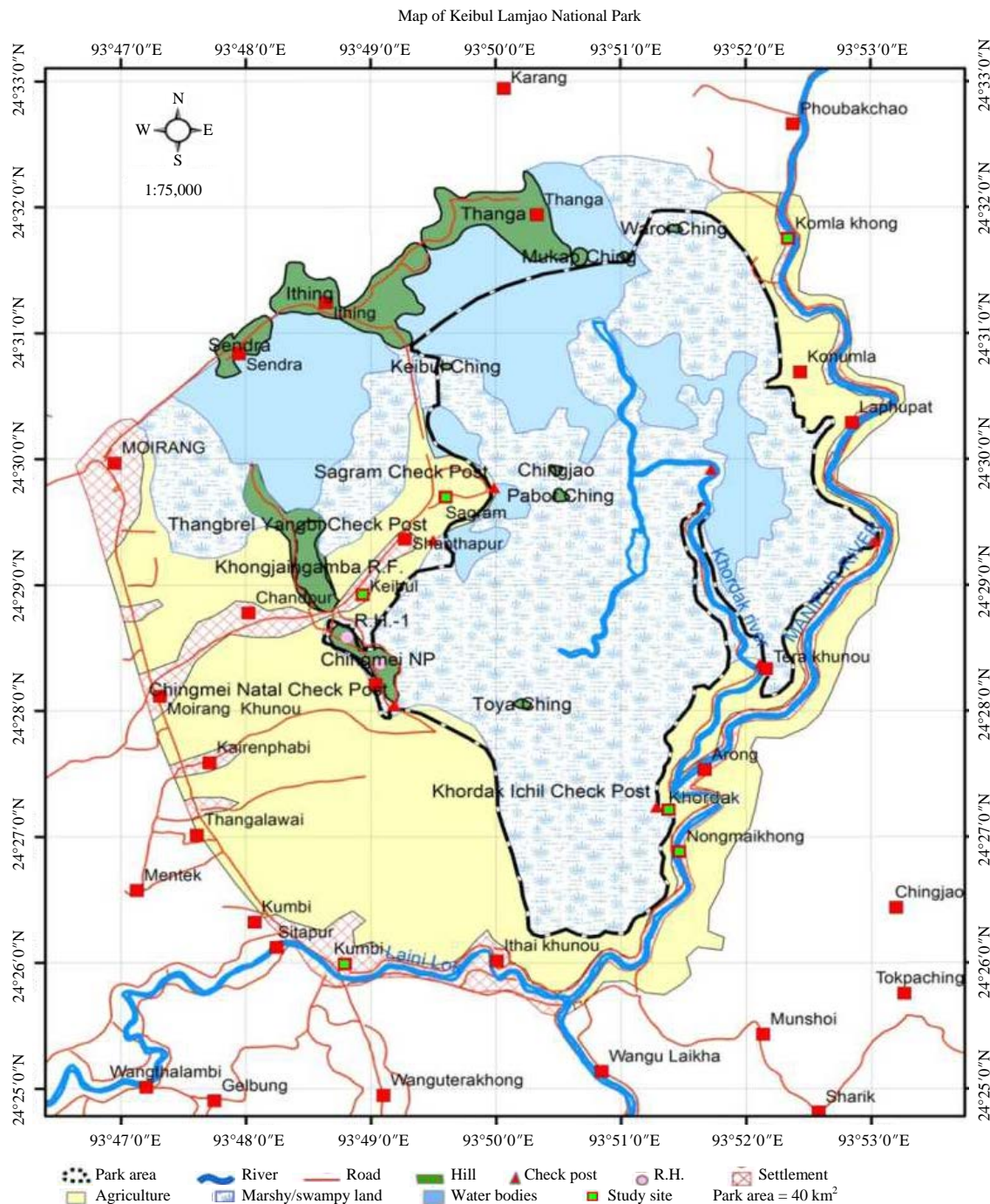


Fig. 2: Map of Keibul Lamjao National Park (KLNP), Loktak lake, Manipur, showing the 6 study sites viz., Keibul, Nongmaikhong, Sargam, Kumbi, Khordak and Komlakhong

To study about the regular periodically survey for the following period i.e., quarterly, in the months of February, May, September and collection and records and colour of the flower was done for phytosociological parameters using the quadrat method. The flowering calendar of KLNP was studied

following the methodologies of previous studies such as Singh *et al.*⁸, Singh⁹, Singh and Nameirakpam¹⁰ and Devi and Nameirakpam¹¹. Plants were identified by the help of available literatures^{12,13,16,19-25} and validity of the plants was checked mostly in <http://www.theplantlist.org/>.

RESULTS AND DISCUSSION

Four plant species viz., *Ageratum conyzoides*, *Alternanthera philoxeroides*, *Leersia hexandra* and *Hedychium coronarium* were found throughout the year in all the 6 sites. Flowering calendars were surveyed and comparison of the stages of flowering period of 6 study sites was incorporated. Maximum number of plants was recorded in Sargam (44), Kumbi (30), Khordak (32) and Nongmaikhong (29) during September-November. Toyaching reached 35, Keibul recorded lowest plant numbers 14 during June-August. The best flowering seasons in KLNP are September-November and June-August. During these two periods maximum number of plants prevailed.

In case of Keibul showed in Fig. 3, maximum number of plants in Keibul was recorded during June-July. During June-July, plants like *Ageratum conyzoides*, *Alpinia nigra*, *Alternanthera philoxeroides*, *Carex setigera*, *Coix lachryma-jobi*, *Colocasia esculenta*, *Crasscephalum crepidioides*, *Leersia hexandra*, *Hedychium coronarium*,

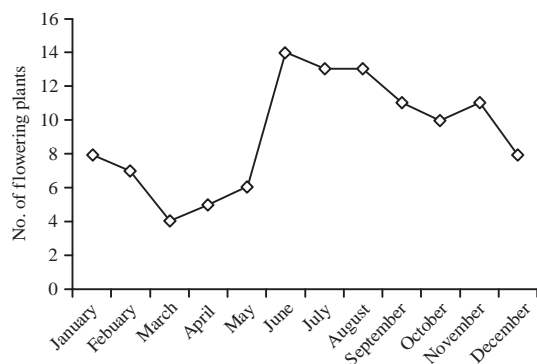


Fig. 3: Stages of the maximum plant under study (Keibul) falls in the month of June and July of the calendar year (2010-11)

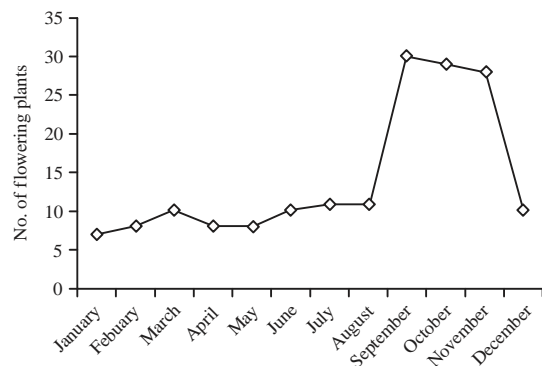


Fig. 4: Stages of the maximum plant under study (Nongmaikhong) falls in the month of September and October of the calendar year (2010-11)

Impatiens chinensis, *Oenanthe javanica*, *Persicaria barbata*, *Sparganium emersum* and *Zizania latifolia* were flowering.

In case of Nongmaikhong showed in Fig. 4, maximum number of plants in Nongmaikhong was recorded during June-July. During September and October plants like *Ageratum conyzoides*, *Ageratum haustonianum*, *Alternanthera philoxeroides*, *Arundo plinii*, *Brachiaria mutica*, *Chrysopsis mariana*, *Colocasia esculenta*, *Commelina bengalensis*, *Crasscephalum crepidioides*, *Leersia hexandra*, *Eclipta prostrata*, *Floscopa scandens*, *Hedychium coronarium*, *Jussiaea suffruticosa*, *Melothria purpusilla*, *Mikania cordata*, *Nymphoides indicum*, *Oenanthe javanica*, *Vigna mungo*, *Phragmites australis*, *Phragmites karka*, *Parsicaria barbatum*, *P. glabra*, *P. sagittata*, *Saccharum bengalens*, *Zizania latifolia*, *Sagittaria guayanensis*, *Cyperus platystylis*, *Cyperus esculentus*, *Saccolipsis interrupta*, *Uraria lagopus* and *Cyperus imbricatus* were flowering.

In case of Kumbi showed in Fig. 5, maximum number of plant in Kumbi was recorded during August-September. During August and September plants like *Ageratum conyzoides*, *Alternanthera philoxeroides*, *Arundo plinii*, *Brachiaria mutica*, *Chrysopsis mariana*, *Cyperus brevifolius*, *Cyperus cyperoides*, *Cyperus digitatus*, *Cyperus umbellatus*, *Leersia hexandra*, *Eichhornia crassipes*, *Enhydra fluctuans*, *Saccharum procerum*, *Floscopa scandens*, *Hedychium coronarium*, *Ipomoea aquatica*, *Ipomoea cairica*, *Jussiaea suffruticosa*, *Ludwigia clavelliana*, *Mikania cordata*, *Nymphoides indicum*, *Panicum sphaerocarpon*, *Vigna mungo*, *Phragmites australis*, *Phragmites karka*, *Persicaria barbata*, *P. glabra*, *P. sagittata*, *Saccharum bengalens*, *Saccolipsis interrupta* and *Persicaria hydropiper* were flowering.

In case of Khordak showed in Fig. 6, maximum number of plant in Khordak was recorded during September-October. During September-October plants like *Ageratum conyzoides*, *Ageratum haustonianum*, *Alternanthera philoxeroides*, *Arundo plinii*, *Brachiaria mutica*, *Chrysopsis*

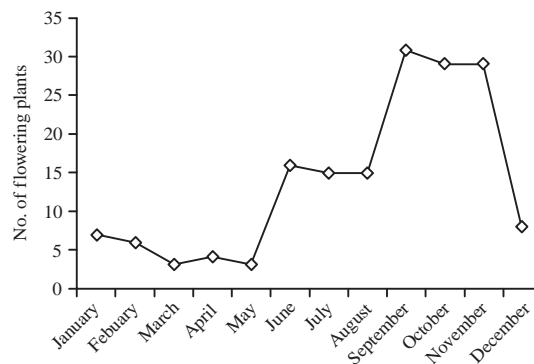


Fig. 5: Stages of the maximum plant under study (Kumbi) falls in the month of August and September of the calendar year (2010-11)

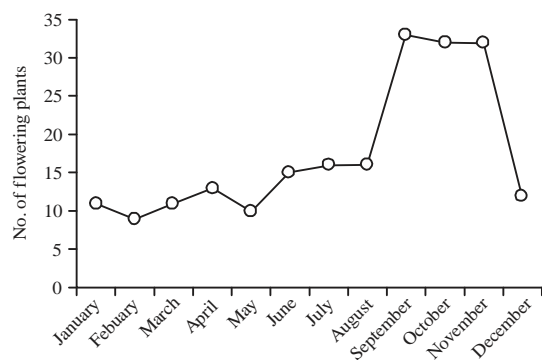


Fig. 6: Stages of the maximum plant under study (Khordak) falls in the month of September and October of the calendar year (2010-11)

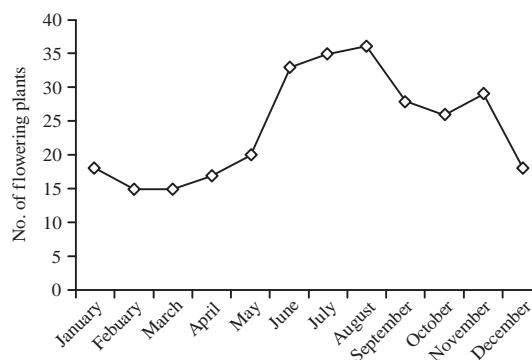


Fig. 8: Stages of the maximum plant under study (Toyaching) falls in the month of July and August of the calendar year (2010-11)

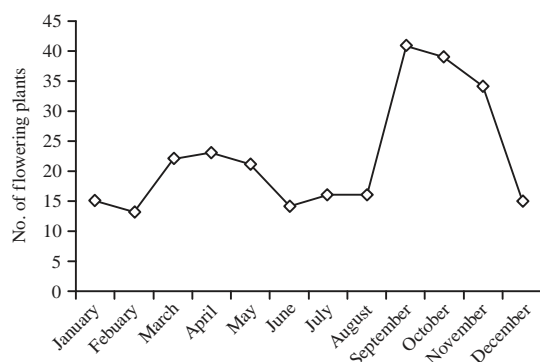


Fig. 7: Stages of the maximum plant under study (Sargam) falls in the month of September and October of the calendar year (2010-11)

mariana, *Crasscephalum crepidiodes*, *Cymbopogon citratus*, *Cyperus umbellatus*, *Dichrocephala latifolia*, *Leersia hexandra*, *Fuirena umbellata*, *Grangea maderaspatana*, *Hedychium coronarium*, *Ipomoea cairica*, *Jussiae suffruticosa*, *Mikania cordata*, *Oenanthe javanica*, *Oryza rufipogon*, *Phragmites australis*, *P. karka*, *P. orientale*, *Saccharum bengalens*, *Saccolipsis interrupta*, *Setaria pumila*, *Sida rhombifolia*, *Floscopa scandens*, *Uria lagopus*, *Cyperus imbricatus*, *Panicum humidorum*, *Cyperus platystylis* and *Fimbristylis tetragona* were flowering.

In case of Sargam showed in Fig. 7, maximum number of plant in Sargam was recorded during September-October. During September and October plants like *Ageratum conyzoides*, *Ageratum haustonianum*, *Alpinia nigra*, *Alternanthera philoxeroides*, *Artemisia parviflora*, *Brachiaria mutica*, *Clerodendrum indicum*, *Rotheca serrata*, *Colocasia esculenta*, *Commelina bengalensis*, *Crasscephalum crepidiodes*, *Cyperus umbellatus*, *Echinochloa curjbelli*, *Leersia hexandra*, *Saccharum procerum*, *Chromolaena odorata*, *Fuirena umbellata*, *Hedychium coronarium*,

Impateins chinensis, *Ipomoea aquatica*, *Ipomoea cairica*, *Ipomoea cairica*, *Jussiae suffruticosa*, *Ludwigia octovalves*, *Mikania cordata*, *Oenanthe javanica*, *Osbeckia chinensis*, *Panicum sphaerocarpon*, *Phragmites australis*, *Phragmites karka*, *Persicaria glabra*, *P. sagittata*, *Saccharum bengalens*, *Setaria pumila*, *Sida rhombifolia*, *Floscopa scandens*, *Chrysopsis mariana*, *Rumex maritimus*, *Bixa orellana*, *Bauhinia purpurea*, *Melia azedarachi* and *Rotala rotundifolia* were flowering.

In case of Toyaching showed in Fig. 8, maximum plant was recorded in Toyaching during July-August. During July and August plants like *Ageratum conyzoides*, *Alpinia nigra*, *Alternanthera philoxeroides*, *Amaranthus spinosus*, *Argyreia nervosa*, *Capparis sabiifolia*, *Chrysopsis mariana*, *Rotheca serrata*, *Coix lachryma-jobi*, *Colocasia esculenta*, *Curcuma angustifolia*, *Leersia hexandra*, *Chromolaena odorata*, *Fuirena umbellata*, *Hedychium coronarium*, *Impatiens chinensis*, *Jussiae suffruticosa*, *Melothria purpusilla*, *Mimosa pudica*, *Momordica dioica*, *Osbeckia chinensis*, *Persicaria barbata*, *Rotala rotundifolia*, *Saccharum bengalens*, *Setaria pumila*, *Zingiber montanum*, *Clinopodium umbrosum*, *Scutellaria discolor*, *Uria lagopus*, *Flemingia macrophylla*, *Acmella paniculata*, *Achyrenthus aspera*, *Cheilocostus speciosus*, *Ficus hispida*, *Persicaria hydropiper* and *Eleusine indica* were flowering.

Figure 9 shows the comparison of flowering calendars with the stages of flowering period of 6 study sites during 2010-2011. Flowering calendars of the study sites were regularly surveyed. Sargam showed maximum number of flowering plants 44, during the period September-November. Toyaching reached the number of plants 35 during the period June-August. In Khordak the numbers of plants were recorded up to 32 during the period of September-November. In Nongmaikhong the number of flowering plants were 29 in the month of

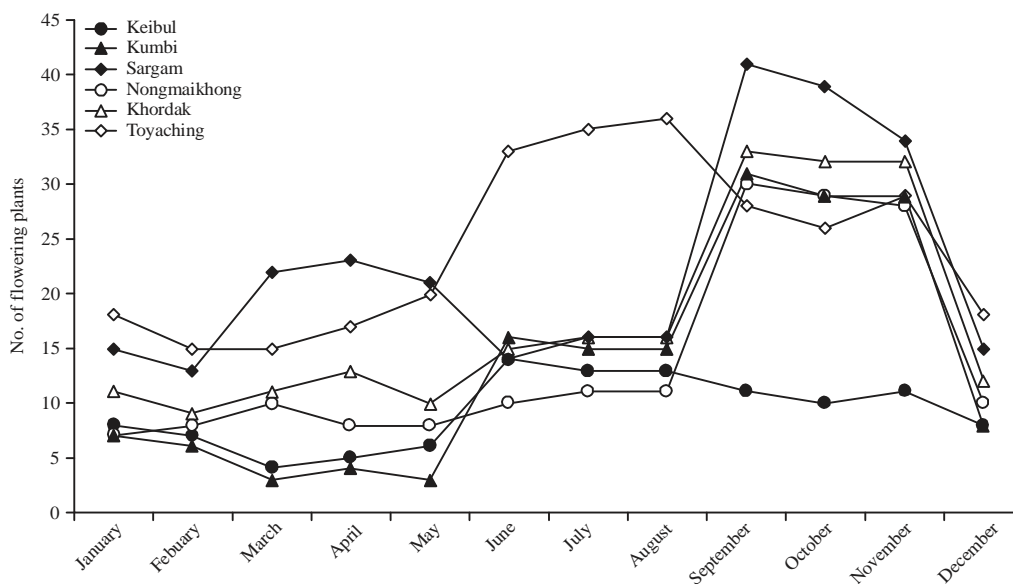


Fig. 9: Comparison of flowering calendar of the stages of flowering period of 6 study sites of KLNP during the calendar year 2010-2011

September-November. In case of Kumbi number of flowering plants reached 30 during the month of September-November. However, lowest plant (14) was noticed in Keibul during the month of June-August. De Novais and Navarro⁷ reported largest numbers of species during July, August, December and January and concluded that there is close relationship with the number of flowers and honey production. Roubik⁶ also supported the above view that study of flowering calendar is necessary to predict the bioresources of a place like honey production. The same research programme is applicable in the present study to predict the availability of bioresources as fodder of animals and wild edible and medicinal plants having ethnobotanical important plants for man during the flowering calendar time.

The KLNP is a highly potential area of international importance and life line for the lake dwellers. Because of its being the habitat of endemic and endangered *sangai* (*Rucervus eldii eldii* McClelland) and other wild animals and availability of their food plants the park is rich in bioresources. As a step towards saving of this rare animal, identification of the plants and its chemical composition is of extreme importance. Devi *et al.*¹³ reported information of biochemical study of ten selected fodder plants of *sangai* for the first time from KLNP. Among the plants best eaten by *sangai* are *Hedychium coronarium*, *Brachiaria mutica*, *Alpinea nigra*, *Oryza rufipogon* and *Zizania latifolia* as important fodder plants for healthy and better conservation of the animal¹³.

During the study four species such as *Ageratum conyzoides*, *Alternanthera philoxeroides*, *Leersia hexandra*

and *Hedychium coronarium* were also recorded throughout the year in all the flowering calendars of 6 sites. *Ageratum conyzoides* is also used as hair lotion and growing in association of other plants. Among these, 3 plants (*Alternanthera philoxeroides*, *Leersia hexandra* and *Hedychium coronarium*) are the food plant of *sangai*, however, *Hedychium coronarium* is the food plant of human beings also. Here, it is evidenced that the study of flowering calendar is correlated with other environmental parameters like behaviour, altitude, pollen emission, pollen load in the atmosphere, etc., proposed by Munshi¹. We need to conserve the natural habitat of KLNP thereby maintaining the luxuriant growth of the seasonal and perennial, macrophytes observed during the flowering periods, so as to maintain the natural flora and fauna of the park. These plants are the food as wild edible and medicinal plants of man and fodder or food of animals, migratory and endemic birds, therefore, it needs a proper care and attention to protect them from over exploitation²⁴.

CONCLUSION

- To study the flowering calendar of KLNP (a Ramsar site and the only unique floating mat Phumdi aquatic environment) will give the information of the macrophytic plants which are used as:
- As a means to survey the availability of the dominant macrophytes for various purposes

- Fodder plants which are the food for the wild animals like *sangai* (*Rucervus eldii eldii* McClelland) an endangered deer species in this globe. If the macrophytes are disturbed by human anthropogenic activities, the natural habitat and food of *sangai* will be disturbed and leading to extinction
- Ethnobotanically important plants of the lake dwellers as food medicinal plants and allergens, thereby maintaining health status of man and animals
- Conservation is required by controlling the human anthropogenic harassments, thereby maintaining the luxuriant growth of the seasonal and perennial, macrophytes observed during the study of flowering calendar, so as to maintain and conserve the natural flora and fauna of the park

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