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Fruiting phenology of trees in the Tropical Montane Evergreen Forest (Shola) of Nilgiri Hills, Western Ghats

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Research Article

Abstract : This paper discuss the fruiting phenology of trees in two shola forests, Longwood (11°43′ N and 076° 87′ E) and Eppanadu (11°29′ N and 076°47′ E) in the Nilgiri hills, Western Ghats, India. A total of 210 individuals belonging to 21 species of 17 families in the Longwood shola and 220 individuals belonging to 22 species in 15 families in Eppanadu shola were tagged and observed for fruiting phenology. Trees showed seasonality in fruiting with a peak during south-west monsoon and a trough in North-east monsoon. Highest fruiting activity was noticed in June and lowest in October during both the years of study. Fruiting behavior of different species varied considerably; while some were highly seasonal, others had staggered fruiting.

Keywords: Fruiting phenology, Nilgiri hills,Western Ghats, India

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1. Introduction

Tropical montane evergreen forest also known as 'shola' forest occurs in the higher elevations of the Western Ghats and its associated hill range in southern India (Champion and Seth, 1968). The shola forests consists of stunted short-boled evergreen trees that are unable to regenerate in open areas due to lack of tolerance to fire and frost (Meher-Homji, 1967; 1987). These forests were found extensively in the higher elevations of the Nilgiris and Palni ranges of Western Ghats, southern India, but due to agricultural expansion, conversion to plantations, livestock grazing pressure and development, a high proportion of this forest type has been destroyed. It has been estimated that half the shola forests in the Nilgiris have been destroyed since 1849 (Kumar, 1993). Monitoring population dynamics, structural and functional characteristics of shola forests over time can provide insights into the responses of these forests to climate and environmental changes. Phenology is the study of the seasonal variation of a species, including a description of variations in structure at different seasons, such as budding, flowering and fruiting (Mishra *et al.,* 2006). The study of plant phenology provides knowledge about the pattern of plant growth and development as well as the effects of environment and selective pressures on flowering and fruiting behavior (Zhang *et al.,* 2006). Fluctuation in flowering and fruiting can be influenced by both biotic and abiotic factors and thus the plants would chose a favourable time to reproduce. Flowering and fruiting seasons of plants very often determine the abundance of pollinators and seed dispersers. Information on phenology of plants in the tropical montane evergreen forests of Western Ghats is limited (Somasundaram and Vijayan, 2010). Hence, the present study was carried out with a goal of assessing the fruiting periodicity of fleshy-fruited tree species in the shola forests.

2. Materials and Methods

The study was carried out in two shola forests namely, Longwood shola (11°43′ N and 076°87′ E) and Eppanadu shola (11°29′ N and 076°47′ E) (Plate 1 & 2), Nilgiri District, Tamil Nadu. Longwood is located at an altitude of 1905 msl and Eppanadu at 2090 msl.

The study area receives rain from both southwest and northeast monsoon and the average rainfall for the years 1998–2000 was 2778 mm (Anon, 2013). These two locations form part of Nilgiri Biosphere Reserve, Western Ghats.

Plate 1: A view of the shola forest in Longwood, Nilgiri District

Plate-2: A view of the shola forest in Eppanadu, Nilgiri District

For phenological observations, 210 individuals belonging to 21 species and 17 families in the Longwood shola and 220 individuals belonging to 22 species and 15 families in Eppanadu shola were tagged (Plate 3).

Plants were tagged with aluminum tags and were numbered. Tagged plants were monitored once in a fortnight for two years from January 2009 to December 2010. During the fornightly visit, percentage of fruit in the canopy was visually estimated and then the estimate was divided into percentage of ripe and unripe fruit, based primarily on colour changes indicating ripeness (Anggraini *et al*., 2000). Binoculars were used for observation, wherever necessary.

3. Results and Discussion

3.1 Monthly fluctuations in fruiting - Longwood shola

The phenology data of shola forests indicates the occurrence of seasonal variations in fruiting. Fruit production occurred year round. Number of species and the individuals in fruits varied in different seasons as well as months. A major fruiting peak was observed in June and trough in October during both the years (Fig 1). A total of 87 individuals belonging to 10 species and 112 individuals belonging to 14 species were recorded in fruiting during 2009 and 2010 respectively. Among the four seasons recognized, south-west monsoon recorded highest fruiting activity and the north-east monsoon the lowest.

Fruiting behaviour of different species varied considerably; while some were highly seasonal others had staggered fruiting. Of the 21 plant species tagged for phenological studies, (*Celtis tetrandra*) (Ulmaceae), *Euodia lunu-ankenda* (Rutaceae) fruited for more than five months. Highest number of fruiting species was recorded in Lauraceae (*Neolitsea scrobiculata, Nothapodytes nimmoniana, Phoebe lanceolata*). Many species showed seasonal fruiting activity. *Nothapodytes nimmoniana* fruits were available from February to April. *Microtropis densiflora* showed extended fruiting with a peak in June, July. *Daphniphyllum neilgherrense* fruits were available for seven months.

3.2 Monthly fluctuations in fruiting - Eppanadu

A total of 65 individuals belonging to 11 species and 114 individuals of 14 species were recorded in fruiting during 2009 and 2010 respectively. Fruiting peak was noticed during June and a trough in October (Fig.2).

Of the 22 plant species belonging to 16 families tagged for phenological studies, *Celtis tetrandra*,*Daphniphyllum neilgherrense*, *Euodia lunu-ankenda* had fruits for more than five months. Lauraceae (*Neolitsea scrobiculata, Litsea wightiana, Cryptocarya lawsonii*), Myrtaceae (*Syzygium montanum, Syzygium densiflorum*) and Ulmaceae (*Celtis tetrandra, Celtis timorensis*) constituted the predominant fruiting species. All other species showed highly seasonal fruiting activity. *Litsea wightiana* fruited from July-September. *Symplocos* species had extended fruiting with a peak during April-May. *Daphniphyllum neilgherrense* fruits were available for six months. Highest numbers of species were in fruits in June (11 in 2009 and 14 in 2010) and lowest (2) in October during both the years of study.

3.3 Seasonal variations in fruiting activity

Longwood shola: The fruiting phenology with reference to seasons, Summer (March–May), South-west Monsoon (June–August), North-east Monsoon (September–November) and Post Monsoon (December –February) indicates the occurrence of fruiting peak in south west monsoon (14 species) and dip in summer (10 species). Table 1 indicates the fruiting of *Daphniphyllum neilgherrense*, *Neolitsea scrobiculata* in all the four seasons and *Euodia lunu-ankenda*, *Ligustrum perrott*etii during three seasons.

Eppanadu shola: The Eppanadu shola also showed the fruiting peak (15 species) during southwest monsoon season. Post monsoon had 11 fruiting species, while summer showed 13 species, north-east monsoon with 12 species. *Euodia lunu-ankenda* showed fruiting in all the seasons followed by *Daphniphyllum neilgherrense*, *Michelia champaca*, *Phoebe lanceolata*, *Nothapodytes nimmoniana*, *Symplocos cochinchinensis* and *Symplocos foliosa* (each 3 seasons) at Table - 2.

4. Discussion

Annual cycles of biotic and abiotic factors which affect tree growth and reproduction over evolutionary time are expected to shape tree phenological patterns (Anderson *et al*., 2005).

Table-1: Fruiting profile of tree species in the Longwood shola forest

S.No	Botanical Name	Summer	South-West Monsoon	North-East Monsoon	Post-Monsoon
1	*Celtis tetrandra*	√	√		
2	*Daphniphyllum neilgherrense*	√	√	√	√
3	*Elaeocarpus oblongus*	√	√		
4	*Euonymous dichotomous*			√	√
5	*Eurya nitida*		√	√	
6	*Euodia lunu-ankenda*	√	√		√
7	*Glochidion-neilgherrense*	√	√		
8	*Isonandra perrottetiana*	√			√
9	*Ixora notoniana*		√	√	
10	*Ligustrum perrottetii*		√	√	√
11	*Memecylon malabaricum*	√			√
12	*Michelia champaca*		√	√	
13	*Microtropics densiflora*		√		√
14	*Myrsine wightiana*	√			
15	*Neolitsea scrobiculata*	√	√	√	√
16	*Nothapodytes nimmoniana*	√			√
17	*Phoebe lanceolata*			√	√
18	*Symplocos cochinchinensis*		√	√	
19	*Syzygium densiflorum*		√	√	
20	*Syzygium montanum*		√		
21	*Turpinia nepalensis*			√	√

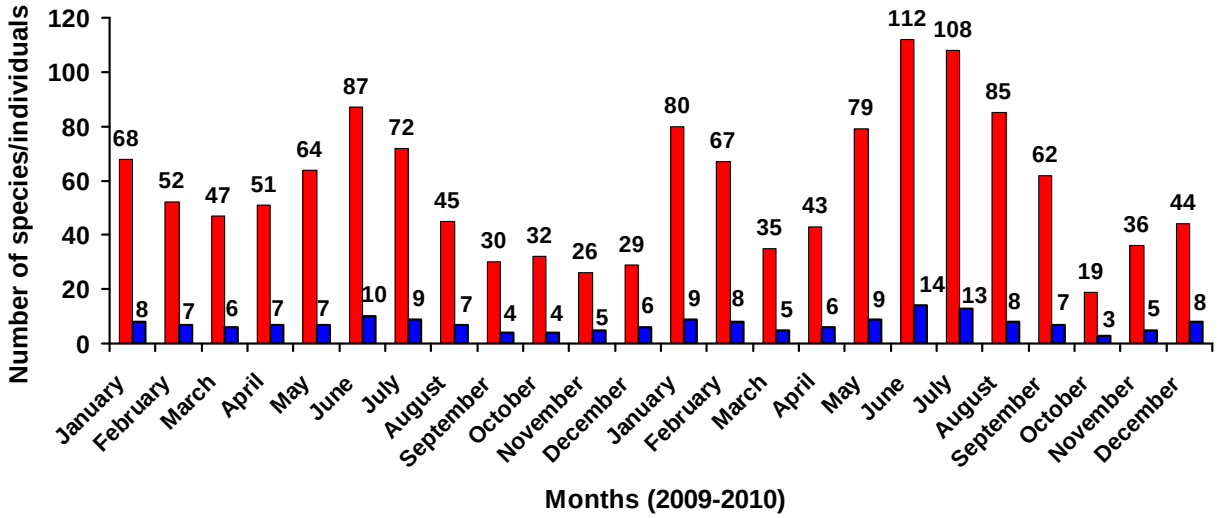

Fig. 1: Fruiting phenology of trees (# of individuals in fruiting in 2009-10) in the Longwood shola (n=21, n=210)

Table- 2: Fruiting profile of fleshy-fruited tree species in the Eppanadu shola forest

S.No	Botanical Name	Summer	South-West Monsoon	North-East Monsoon	Post-Monsoon
1	*Celtis tetrandra*	√	√		
2	*Celtis timorensis*	√	√		
3	*Cryptocarya lawsonii*		√		
4	*Daphniphyllum neilgherrense*	√	√	√	
5	*Elaeocarpus oblongus*	√	√		√
6	*Euodia lunu-ankenda*	√	√	√	√
7	*Glochidion neilgherrense*		√		√
8	*Ixora notoniana*		√	√	
9	*Ligustrum perrottetii*	√	√	√	
10	*Litsea wightiana*		√	√	
11	*Microtropis densiflora*		√	√	√
12	*Michelia champaca*	√	√	√	
13	*Myrsine wightiana*	√			
14	*Neolitsea scrobiculata*		√		√
15	*Nothapodytess nimmoniana*	√		√	√
16	*Phoebe lanceolata*	√		√	√
17	*Schefflera racemosa*	√			
18	*Symplocos cochinchinensis*	√		√	√
19	*Symplocos foliosa*	√		√	√
20	*Syzygium densiflorum*		√		
21	*Syzygium montanum*		√		√
22	*Turpinia nepalensis*			√	√

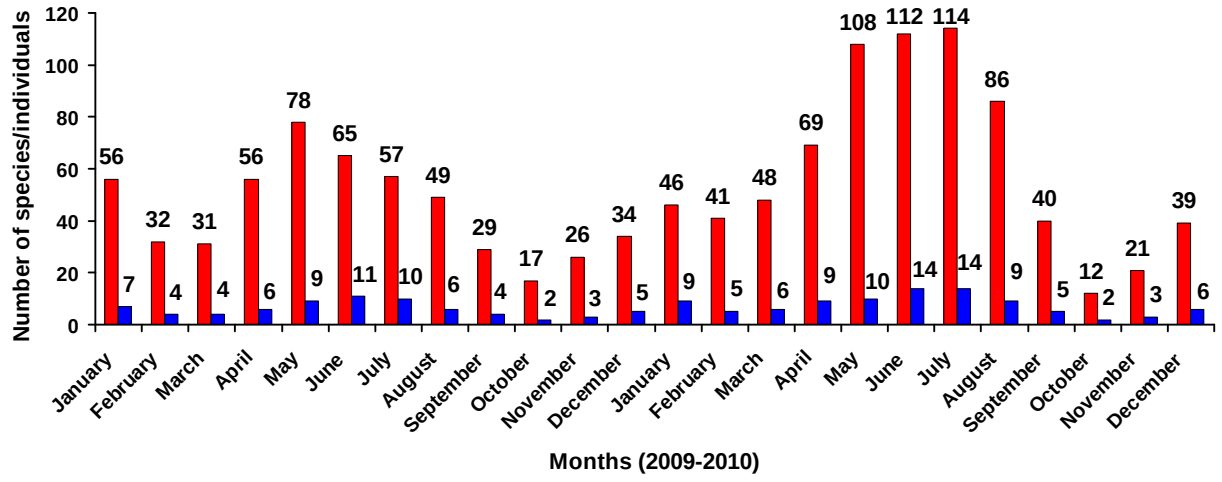

Fig. 2: Fruiting phenology of trees (# of species and # of individuals in fruiting) in the Eppanadu shola (n=22, n=220)

Michelia champaca

Syzygium densiflorum

Litsea wightiana

Daphniphyllum neilgherrense

Microtropis densiflora

Ligustrum perrottetii

The present study reported the occurrence of ripe fruits throughout the year with a peak in during the onset of southwest monsoon. The fruiting peak after the onset of monsoon has been reported in many other tropical montane forests (Koptur *et al*., 1988; Sun *et al*. 1996; Kimura *et al.* 2001; Sundarapandian *et al.,* 2005; Somasundaram and Vijayan, 2010). In the Kukkal shola of Western Ghats, (Somasundaram and Vijayan, 2010) recorded the availability of ripe fruits round the year with a peak in July in both the years of study. After the heavy rains, the number of fruiting species decreased. In a Brazilian montane forest site also (Funch *et al*., 2002) highest fruiting activity was reported during rainy season. Lieberman (1982) and Ratheke and Lacey (1985) hypothesized that high water availability is necessary at the time of fruit maturation and germination success. The highest fruiting activity of trees in sholas during monsoon may be an adaptation to utilize the moisture content for fruit maturation and seed germination.

Fruiting pattern of tree species in the present study area shows the presence of various guilds of fruiting species. While three species produced fruits throughout the year, 21 produced seasonally, and two irregularly. A comprehensive 4-year study of the phenology of flowering and fruiting in a Philippine submontane rain forest found 34 tree species reproduced once a year, 13 reproduced continuously, 3 superannually and 7 irregularly (Hamann 2004). Fleshy-fruited species of the 'montane group' fruited all the year round without a distinct fruiting season. Such a seasonal tendency resulted from high proportions of plants bearing fruits continuously and annual/biannual fruiting species fruiting all through the year. Plant species with continuous fruiting usually bore a little fruit in every census and even plant species with annual, biannual fruiting produced less fruits when they fruited asynchronously (Kimura *et al.* 2001). Such a low rate of fruit production through the year may be adaptive for a low density of birds and a small number of resident bird species (Poulin *et al.* 1999; Thompson and Willson, 1979).

Conclusion

From the present study it is inferred that the tree flora of shola forests have a definite fruiting seasonality which is in concurrence with the findings from many other tropical forests.

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6. References

Anderson, D. P., Nordheim, E.V., Moermond, T.C., Gonc, Bi Z B. and Boesch, C. 2005. Factors influencing tree phenology in Tai National Park. Cote d'lvoric. *Biotrop*., 37: 631-640.

Anggraini, K., Kinnaird, M., and O' brien, T. 2000. The effect of fruit availability and habitat disturbance on an assemblage of Sumatran hornbills. *B. Consv. Int.,* 10: 189-202.

Anonymous, 2013. Report of the high level working group on Western Ghats. Vol II. Ministry of Environment and Forests, Govt. of India.

Champion, H.G. and Seth, S.K. 1968. A Revised Survey of the Forest Types of India. Manager of Publications. Government of India, New Delhi.

Funch, L.S., Funch, R. and Barrosco, G. M. 2002. Phenology of gallery and montane forest in the Chapada Diamanina, Bahia, Brazil. *Biotrop.,* 34: 40 –50.

Hamann, A. 2004. Flowering and fruiting phenology of a Philippine submontane rain forest: climatic factors as proximate and ultimate causes. *J. Ecol*., 92:24–31

Kimura, K., Yumoto, T., and Kikuzawa, K. 2001. Fruiting phenology of fleshy-fruited plants and seasonal dynamics of frugivorous birds in four vegetation zones on Mt. Kinabalu, Borneo. *J. Trop. Ecol.,* 17:833 -858.

Koptur, S., Herbert, W. A., Frankie, G. W., and Baker H. G. 12. 1988. Phenological studies of shrubs and treelet species in tropical cloud forests of Costa Rica. *J. Trop. Ecol*., 4: 323–346.

Kumar, S. 1993. Survey and mapping of shola forests and grasslands in the Upper Nilgiri Plateau and Assessment of human utilization of the vegetation. Project Report, World Wild Fund for Nature-India.

Lieberman, D. 1982. Seasonality and phenology in a dry tropical forest in Ghana. *J. Eco1*., 70: 791.

Meher-Homji, V. M. 1967. Phytogeography of south Indian hill stations. *Bull. Torrey Bot. Club.,* 94: 230-242.

Meher-Homji, V. M. 1987. Ecological diversity in the Nilgiri district. *J. Palynol*., 23-24: 159-166.

Mishra, R.K., Upadhyay, V.P., Mohapatra, S.B. and Mohanty, R.C. 2006. Phenology of species of moist deciduous forest sites of Simlipal Biosphere Reserve. *Lyon.,* 11(1): 5-17.

Poulin, B., Wright, S. J. and Lefebvre, G. 1999. Inter-specific synchrony and asynchrony in the fruiting phenologies of congeneric bird-dispersed plants in Panama. *J. Trop. Ecol*., 15: 213-227

Rathcke, B and Lacey, E. P. 1985. Phenological pattern of terrestrial plants. *Ann. Rev. Ecol. Syt*., 16: 179-214.

Somasundaram, S. and Vijayan, L. 2010. Plant diversity and phenological pattern in the montane wet temperate forests of the southern Western Ghats, India. *For. Stud. China*, 12(3): 116–125.

Sun, C., Kaplin, B. A., Kristensen, K. A., Munyaligoga, V., Mvukiyumwami, J., Kajondo, K.K. and Moermond, T. C. 1996. Tree phenology in a tropical montane forest in Rwanda. *Biotrop*., 28:668-681.

Sundarapandian, S.M., Chanderasekaran, S., and Swamy, P.S. 2005. Phenological behavior of selected tree species in tropical forests at Kodayar in the Western Ghats, Tamil Nadu, India. *Curr. Sci.,* 88: 805-810.

Thompson, J.N., and Willson, M.F. 1979. Evolution of temperate fruit/bird interactions: phenological strategies. *Evol.* 33: 973-982.

Zhang, G. Song, Q., and Yang, D. 2006. Phenology of *Ficus racemosa* in Xishuangbanna, Southwest China. *Biotrop*., 38(3): 334-341.