Towards understanding species interactions and their impact on the environment. A variety of factors have been shown to influence the phenology of tropical forests (Wright, 1996). Plant phenology is affected by environmental conditions such as rainfall, temperature, and relative humidity (Wright and Van Schaik, 1994). Abiotic environmental conditions have been shown to play a significant role in the timing of various phenological events. Seasonal changes in abiotic and biotic factors can be expected to have consistent effects on phenology of tropical forests (Wright, 1996). Plant phenology is sensitive to climate and a key indicator of environmental change (Badeck et al., 2004; Estrella et al., 2007; Penuelas et al., 2009 and Yang and Rudolf, 2010). Phenological changes to be more rigorously used as early warning systems of potential climate impacts on species distributions (Menzel et al., 2006; Cleland et al., 2007 and Crimmins et al., 2009). Tropical plants with their high level of species diversity display phenological events such as leaf drop, leaf flushing, flowering and fruiting etc. in relation to time and space (Justiniano and Fredericksen, 2000; Singh and Singh, 1992). As plants reach the various developmental stages of their annual life cycle and the timing of a plant often provides information for estimating geographic, climatic variation on a local scale (Kalb, 1962). No such phenological studies have been reported in Kallamalai hills; in this perspective, the study has been convened.

MATERIALS AND METHODS

Study area

The study was carried out at Kallamalai hills, Raspipuram Taluk, Namakkal district, Tamil Nadu, India. The study area is situated between 11° 51’ N latitude and 78° 12’ E longitude and it is located in between Salem and Raspipuram towns. Kallamalai hills are considered a part of Boda hills of the Southern Eastern Ghats of the Eastern Ghats Gurveen Kaur et al., (2013). The average height of the hills is about 616m and covers an area of approximately 350 acres The average annual rainfall in this region is 76mm. The Kallamalai hills are tropical dry deciduous thorny type of vegetation.

Seasonal periods

Kallamalai hills have experienced by four seasons in a year

1. Post monsoon season January to March
2. Pre monsoon season April to June

ABSTRACT

The study was carried out at Kallamalai hills, Raspipuram Taluk, Namakkal district, Tamil Nadu, India. The vegetation analysis was enlisted 464 species and 251 genera of angiosperms belong to 75 families. During Post monsoon period Jan-Feb 24 species (5.19%) were in flowering and 133 species (28.79%) were in fruiting. In Pre monsoon period March-May 37 species (8.01%) were in flowering and 54 species (11.69%) were in fruiting. In south west monsoon period June-Sep 75 species (16.23%) were in flowering and 27 species (5.84%) were in fruiting. In North West monsoon period Oct-Dec 187 species (40.48%) were in flowering and 58 species (12.55%) were in fruiting. Flowering phenology largely take place during North West monsoon and fruiting phenology largely take place during Pre monsoon as evidenced by the study.
RESULTS

Results on flowering and fruiting phase of plant species in Kallamalai Hills were in fruiting throughout the year. Pre and Post monsoon periods About 103 species (22.29%) were in flowering in both North West and Post monsoon periods 35 species (7.58%) were in fruiting in both North West and Post monsoon periods 58 species (12.55%) were in fruiting. It is found that 48 species (58.4%) and in the North West monsoon period from March to June 37 species (80.1%), in the South West monsoon period from July to September 25 species (58.4%) and in the North West monsoon period from July to September 75 species (23.14%) and in the Pre monsoon period from April to June 37 species (80.1%), in the South West monsoon period from July to September 25 species (58.4%) and in the North West monsoon period from July to September 75 species (23.14%) and in the Pre monsoon period from April to June 37 species (80.1%) were in flowering. About 95 species (20.56%) were in flowering throughout the year.

Flowering phase of herbs was observed throughout the year, during the North West monsoon period 114 species (51.12%), in the South West monsoon period 28 species (12.56%), in the Post monsoon period 5 species (2.24%) and in the Pre monsoon period 4 species (1.79%) were in flowering. Species flowered in both seasons are also recorded and the results revealed that in the North West and Post monsoon periods 10 species (4.48%), in the Post and Pre monsoon periods 2 species (0.89%), in the South West and North West monsoon period 1 species (0.45%) and in the North West Post and Pre monsoon periods 3 species (1.35%) were in flowering. About 56 species (25.11%) were in flowering throughout the year.

Phenology of Trees

During the Pre monsoon period 27 species (31.39%), in the South West monsoon period 20 species (23.26%) and in the North West monsoon period 17 species (19.77%) were in flowering. During Post monsoon period 10 species (11.63%) in the North West and Post monsoon periods 2 species (2.33%) in the South West North West and Post monsoon periods 2 species (2.33%) were in flowering and in the South West and North West monsoon periods 1 species (1.16%) were in flowering. About 59 species (26.46%) were in flowering throughout the year.

Phenology of Shrubs

Phenology of shrubs was monitored and it constitutes 11.47% of the flora. During North West monsoon period 18 species (33.96%), in the South West monsoon period 9 species (16.98%), in the Post monsoon period 3 species (5.67%), in the North West and Post monsoon periods 2 species (3.77%) were in flowering. In the North West and Post monsoon periods 1 species (1.89%) in the Post and Pre monsoon periods 1 species (1.89%) are in flowering. In the Pre and North West monsoon periods and South West monsoon periods 1 species (1.89%) are in flowering.
Fruiting phase of shrubs during the North West monsoon period 11 species (20.75%), in the Post monsoon period 9 species (16.98%) and in the Pre Monsoon period 4 species (7.55%) were in fruiting. In the South West monsoon 1 species (1.89%), in the North West and Post monsoon periods 6 species (11.32%), in the Post and Pre monsoon periods 4 species (7.55%) and 18 species (33.96%) were fruiting in throughout the year.

**Phenology of Prostrate Herbs**

Flowering phase of Prostrate herbs was observed and its constitutes 6.28 % of flora. During North West monsoon period 10 species (34.48 %), in the South West monsoon period 5 species (17.24%) were in flowering. In the North West and Post monsoon periods 5 species (17.24%) and in throughout the year 9 species (31.03%) were in flowering.

Fruiting phase of prostrate herbs was observed and resulted as below during the Post monsoon period 9 species (31.03%), in the North West monsoon period 2 species (6.89%) and in the South West monsoon period 1 species (3.45%) were in fruiting. In the North West and Post monsoon periods 4 species (13.79%), in the Post and Pre monsoon periods 3 species (10.34%) and in throughout the year 10 species (34.48%) were in fruiting.

**Phenology of Climbers**

The flowering of Climbers was observed and it constitutes 6.28 % of flora. During the North West monsoon period 12 species (41.38%), in the South West monsoon period 7 species (24.14%) and in the Post monsoon period 2 species (6.89%) were in flowering. In the Pre monsoon period 1 species (3.45%), in the North West and Post monsoon periods 1 species (3.45%) and in throughout the year 6 species (20.69%) were in flowering.

The Fruiting phase of climbers was observed during the Post monsoon period 7 species (24.14%), in the North West monsoon period 5 species (17.24%) and in the Pre monsoon period 3 species (10.35%) were in fruiting. In the North West and Post monsoon periods 5 species (17.24%), in the Post and Pre monsoon periods 4 species each (13.79%) and throughout the year 5 species (17.24%) were in fruiting.

**DISCUSSION**

In the study area, flowering was largely take place during the North West monsoon as evidenced by results. The flowering commences during the South West monsoon and peak of flowering occurs at the end of the North West monsoon. This observation of the study was similar to other studies such as (Liberman 1982, Lott et al, 1990, De Lampe et al, 1992, Sun et al, 1996, Justiniano and Fredericksen, 2000). After the Post monsoon, high temperature with rising humidity favours flowering and this finding is similar to the reports of Croat, 1975, Murali and Sukumar, 1994, Stranghetti and Taroda, 1997. The flowering was least in the North West monsoon and Post monsoon and it is similar to the other studies mentioned above. The fruiting was largely takes place during the Post monsoon as evidenced by plant species in the study. The fruiting commences during the North West monsoon and peak of fruiting occurs at the end of Post monsoon. This observation of the study was similar to other studies like Liberman, 1982, Lott et al, 1990, De Lampe et al, 1992, Sun et al, 1996, Justiniano and Fredericksen, 2000. The flowering was least in the South West monsoon, after the North West monsoon with rising humidity favours fruiting and this finding is similar to the reports of Croat, 1975, Murali and Sukumar, 1994, Stranghetti and Taroda, 1997.

In this present study leaf flushing and leaf fall happens before the onset of rains, however leaf flushing is in dry season agreed with other observation (Justiniano and Fredericksen, 2000). Trees initiated flowering during the beginning of the dry season at the time most of the trees were leafless or leaf flushing stage. Fruiting was initiated at the end of dry season and fruiting largely take place in the Pre monsoon and least in the North West monsoon. As flower initiation can advertise to pollinators as they get pollinated as seen in other tropical forest (Murali and Sukumar, 1994, Sundarapandian et al, 2005).

Herbs were initiated flowering during the end of rainy season and the beginning of the winter season. The flowering of herbs largely takes place during the North West monsoon and least in the Pre monsoon as evidenced by the result. The flowering commences during the South West monsoon and peak of flowering occurs at the end of the North West monsoon. The herbs initiated flowering during winter season and maximum fruiting was take place during the Post monsoon and least in the Pre monsoon period.

Shrubs were initiated flowering during the end of rainy season. The flowering of shrubs largely takes place during the North West monsoon and least in Post and Pre monsoon as evidenced by the result. The flowering commences during the South West monsoon and peak of flowering occurs at the end of North West monsoon. The fruiting of shrubs initiated during the beginning of the summer season and maximum fruiting takes place in the North West monsoon and least in the South West monsoon.

Climbers initiated flowering during the end of rainy season. The flowering of climbers largely takes place during the North West monsoon and least in Pre monsoon periods. The flowering commences during the South West monsoon and peak of flowering occurs at the end of the North West monsoon. The climbers initiated fruiting during the beginning of summer season and maximum fruiting take place in the Post monsoon and least in Pre monsoon.

**A comparison of Phenology of plant species of Kallamalai hills and An excursion flora central Tamil Nadu India by Matthew1991**

An attempt has been made to compare the phenology of plant species of Kallamalai flora documented during 2015 with that of “An Excursion Flora of Central Tamil Nadu India” flora by Matthew 1991. The Matthew flora was documented during 1991 covering Pacchaimalai hills, Kolli hills, Bodamalai hills, Kalrayan hills, Servarayan hills and Melagiri hills of central Tamil Nadu. The present study area Kallamalai hills are a part of Bodamalai hills. The comparison was aimed to have knowledge of plant species phenology of Kallamalai hills studied in different periods. The phenology of plant species during the Post Monsoon period (Jan-Mar) 51.9% of species were in flowering and whereas 26.94% of species were flowering in Matthew study. In the Pre Monsoon period (Apr-
During the Post Monsoon period (Jan-Mar) 28.79% of species were flowering in the study area and 10.63% of species were flowering in Matthew flora. In the Pre Monsoon period (Apr-Jun) 11.69% species were flowering in the study area and 7.25% of species were flowering in Matthew flora. During the South West Monsoon period (Jul-Sep) 5.84% of species were flowering in the study area and 9.18% of species were flowering in the Matthew flora. In the North West monsoon period (Oct-Dec) 12.55% of species were flowering in the study area and 22.29% of species were flowering in Matthew flora. About 22.29% of species were flowering throughout a year in the study area and 25.71% species were flowering in Matthew flora.

The study revealed the floristic composition and phenology of the study area and comparison revealed the variation in flowering and fruiting of plant species of different years of the study. Abiotic environmental conditions such as rainfall, changes in temperature might have shown to play a significant role in the timing of various phenological events, but the reasons for the variation to be studied and to be analyzed.

**Acknowledgements**

The heartfelt thanks to the Chairman, Vivekanandha Educational Institutions for granting permission to pursue the work. The author also thankful Dr.P. Manikanadan Asst. Professor in Botany, Vivekanadha College of Arts and Sciences for Women, for his help in the identifying some plants.

**References**


Justiniano M.J. and Fredericksen T.S. (2000). Phenology of timber tree species in a Bolivian Dry forest implication period 40.48%. Fruiting dominance in Matthew flora was throughout year 53.14% and in the present study fruiting of plant species was dominant in the Post monsoon period 28.79%. The study revealed the floristic composition and phenology of the study area and comparison revealed the variation in flowering and fruiting of plant species of different years of the study. Abiotic environmental conditions such as rainfall, changes in temperature might have shown to play a significant role in the timing of various phenological events, but the reasons for the variation to be studied and to be analyzed.


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**How to cite this article:**