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Research Article

FLORISTIC, PHENOLOGICAL AND LIFE FORM SPECTRUM ANALYSIS IN VILATHIVILAI AREA, KANYAKUMARI DISTRICT, TAMIL NADU, S. INDIA

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ABSTRACT

Floristic composition, phenological and life form analysis of Vilathivilai, Pazhavilai was studied from August 2012 to January 2013. A total of 60 plant species belonging to 32 families were recorded during the present course of study. Life form spectrum revealed the dominance of Threophytes (78.3%) and these were followed by Chameophytes (8.3%), Geophytes (5%), Phenorophytes (5%) and Hemicryptophytes (3.3%). Therophytes were found higher than the normal biological spectrum which indicated that study area is under biotic pressure. The phenological data of the study area revealed that just on the set of early monsoon shower in the last week of October and November resulted in the growth of new seedlings. During the post summer season and in the early monsoon, the study area became green and the area was covered by vegetation. Most of the phenological events in the observed plants are induced by photo period and temperature. This information may be used as base line for further evaluation of phenological variations in response of the climate change.

Keywords: Analysis, Floristic, Life Form, Phenology and Spectrum.

INTRODUCTION

Vegetation is an important part of an ecosystem that interprets the effects of total environment[1]. Vegetation complex fluctuates from season to season in a cycle over the years in a successional way and the fluctuations suggest a response by each species population to prevailing heat, moisture and light as modified by the vegetation itself. It is a system which is an expression of statistical distribution of species among different life-forms, called biological spectrum[2]. The biological spectrum of region i.e. list of percentage of different life-form classes represented in the total flora, displays an obvious relationship to the climate. Phenology is a calendar event period of seed germination, vegetative growth, flowering, fruiting, seed setting, death and decay, etc. Plant phenological study has great significance because it not only provides knowledge about plant growth pattern but it also provides the idea on the effects of environment and selective pressure on flowering and fruiting behaviour[3].

The first phenological network in Europe is linked with the name of Carl Vom Linne, who made his observations in Sweden[4]. The International Phenological Garden (IPG) is nowadays a unique system in Europe. It observes 7 phenophases of 23 plant species and measures the growing period, the concentration of carbon dioxide and the change of spring temperature. There are networks in several countries of Europe, such as in Albania, Austria, the Czech Republic, Estonia, Germany, Poland, Russia, Slovakia, Slovenia, Spain and Switzerland. [5] studied relationships between various phenophases (ie., seasonal biological events) and interannual variations of air temperature in three woody plant species (*Prunus davidiana, Hibisucs syriacus,* and *Cercis chinensis*) in the Beijing metropolis, China based on phenological data for the period 1951-2004. [6] investigated flowering phenology and reproductive output of sister species of Barrel cacti, *Ferocactus cylindraceus* and *F. Wislizeni,* where they occur sympatrically in the Sonoran Desert surrounding Tucson, Arizona. *Ferocactus cylindraceus* began blooming in May and continued until early or mid-October, with a bimodal pattern of flowering amplitude

MATERIALS AND METHODS

Study Area:

Pazhavilai (Vilathivilai) is a small village (2sq km area) located at 8 km from Nagercoil, Tamil Nadu, and India. It is located near the Nagercoil-Colachel Road. It is famous for

Kamarajar Polytechnic College and Block Development Office (famously referred as Block Office) of Rajakkamangalam panchayath. The Green environment with rich coconut plants, Cashew nut trees and Banana plantations prevailing in the village is marvelous. Extensive field survey was conducted in the study area (Vilathivalai, Kanyakumari district) from August 2012 to January 2013 in order to record the floristic study,phenology and biological spectrum. Detailed sampling was done of monthly intervals following[7]. Data on floristic composition, life form; (on the basis of nature of perennating buds of plant species) habit and phenology of the constituent species were recorded. Collected plant specimens were identified by using [8, 9]. All species were assigned a suitable life form such as phanerophytes (ph), Chamaephytes (Ch), Hemicryptophytes (Hg), Geophytes (G) and Therophytes (Th) and a biological spectrum was prepared. This was compared with the [2] normal biological spectrums. The climate is dry and monsoonic with three different seasons viz. summer, rainy and winter (summer – August, September, up to middle October; Rainy –October last week, November; winter –December and January).

RESULTS

A total of 60 plant species belonging to 32 families were presently recorded from the study area (Table -1). These include 40 erect, 11 Prostrate, 5 climbers and 4 erect prostrate (Table -2). Prevalence of varied climate conditions, resulting from study area showed a difference seems to be responsible for occurrence of such diverse floristic components. Euphorbiaceae with seven species emerged out to be the most dominant family, *Croton bonplandianum, Phyllanthus simplex, Euphorbia heterophylla, Acalypha indica, Phyllanthus niruri, Croton sparsiflorus* and *Euphorbia hirta* were the most commonly occurring species. They occupied varied habitats exhibit maximum niche diversity and indicate there by a better adaptability to different environmental regimes. Amaranthaceae, Poaceae and Asteraceae (4 species each) are subsequently followed by Rubiaceae, Solanaceae, Verbenaceae and Apocynaceae (3 species each) in terms of species strength. Cyperaceae, Capparidaceae and Scrophulariaceae had two species each and Caesalpiniaceae, Annonaceae, Sapindaceae, Combretaceae, Bignoniaceae, Boraginaceae, Passifloraceae, Fabaceae, Acanthaceae, Onagraceae, Convolvulaceae, Commelinaceae, Cucurbitaceae, Asclepiadaceae, Brassicaceae, Nyctaginaceae and Lythraceae had one species each (Table -1).

In the biological spectrum, the trend of [2] life forms present study sites are observed as Threophytes (78.3%) > Chameophytes (8.3%) > Geophytes (5%), Phanerophytes (5%) > Hemicryptophytes (3.3%) (Table -3 and 4). In the present study, majority of the plant species are dicot (53) than Monocot (7).

In the present study, majority of plant species recorded in flowering, fruiting and maturing seeds during the month of August and September but soon after in the month of late September plants dry and fruits become disseminated through various agencies. Nearly 40% plant species disappear after at the end of September due to extremely hot atmospheric condition and lack of moisture in the soil.

During the starting of rainy season (November) new plants start their germination while a few others survive in vegetative, flowering and fruiting stage. These were *Alternanthera sessilis, Amaranthus viridis, Brassica campestris, Mollugo hirta, Justicia diffusa, Boerhaavia diffusa, Passiflora foctida, Heliotropium indicum, Leucas aspera Cleome viscosa, Cordiospermum helicacabum, Duranta plumieri, Croton sparsiflorus, Vinca rosea, Solanum surattense, Vernonia cinera* and *Mollugo hirta.*

TABLE I: FLORISTIC COMPOSITION, LIFE FORM, HABIT AND PHENOLOGY OF THE CONSTITUENT SPECIES IN THE STUDY AREA (VILATHIVILAI, K.K.DIST).

Sl. No	Plant species	Family	Life form	Habit	Phenology (Months)					
					Aug	Sep	Oct	Nov	Dec	Jan
1	*Acalypha indica* Linn.	Euphorbiaceae	Th	Et	1,2	1,2	1,2	3,4	3,4	3,4
2	*Achyranthes aspera* Linn.	Amaranthaceae	Ph	Et	2,3,4	-	1,2	1,2	2,3,4	3,4
3	*Allamanda cathartica* Linn	Apocynaceae	Th	Et	3,4	3,4	3,4	3,4	3,4	3,4
4	*Alternanthera sessilis* (Linn) DC	Amaranthaceae	Th	Pr	-	-	-	1	1,2	2,3,4
5	*Amaranthus spinosus* Linn.	Amaranthaceae	Th	Et	-	-	1,2	1,2	2,3,4	4,5,6
6	*Amaranthus viridis* Linn.	Amaranthaceae	Th	Et	2,3,4	2	1,2	1,2	2,3	2,3,4
7	*Ammannia baccifera* Linn.	Lythraceae	Th	Et	3,4	4,5	1,2	1,2	1,2	1,2
8	*Annona squamosa* Linn.	Annonaceae	Th	Et	-	-	-	2	2	2
9	*Boerhaavia diffusa* Linn.	Nyctaginaceae	He	Et/Pr	3,4,5	5,6	1,2	1,3	2,3	2,3
10	*Brassica campestris* Linn.	Brassicaceae	Th	Et	5	6	1	1,2	1,2	2,3
11	*Caesalpinia pulcherima* Linn.	Caesalpinaceae	Th	Et	3,4	3,4	3,4	3,4	3,4	3,4
12	*Calotropis gigantea* (Linn) R.Br	Asclepiadaceae	Ph	Et	3,4,5	3,4,5	3,4,5	3,4,5	3,4,5	5
13	*Cardiospermum helicacabum*	Sapindaceae	Ph	Cl	-	-	1,2	2	2,3	3,4

	Linn.									
13	*Chloris barbata* L.	Poaceae	Th	Et	-	-	-	2	2,3	2,3
14	*Cleome viscosa* Linn.	Capparidaceae	Th	Et	-	-	1,2	1,2	3,4	3,4
15	*Clitoria ternatea* Linn.	Fabaceae	Th	Cl	5,6	-	1	2	2	2,3
16	*Coccinia indica* wt. & Arn.	Cucurbitaceae	Th	Cl	1	2	2,3	2,3	3,4	3,4
17	*Commelina benghalensis* Lin.	Commelinaceae	Th	Pr	-	-	2	2	2,3	2,3
18	*Croton bonplandianum* Baill	Euphorbiaceae	Th	Et	2	2,3	2,3	3,4	3,4	3,4
19	*Croton sparsiflorus* Linn.	Euphorbiaceae	Th	Et	-	-	1,2	1,2	1,2	3,4
20	*Cynodon dactylon* (Linn.) Pers	Poaceae	Ch	Et/ Pr	-	-	-	2	2	2,3
21	*Cyperus kyllingia* Endl.	Cyperaceae	G	Et	1	1,2	2,3	2,3,4	3,4	-
22	*Cyperus rotundus* linn.	Cyperaceae	G	Et	1	1,2	2,3	2,3,4	3,4	-
23	*Duranta plumieri.* Jacq	Verbenaceae	Th	Et	-	-	-	1,2	1,2	1,2
24	*Eclipta prostrate* (Linn.)	Asteraceae	Th	Et/ Pr	-	-	1,2	2,3	2,3	2,3,4
25	*Euphorbia heterophylla* linn.	Euphorbiaceae	Th	Et	1,2	1,2	3,4,5	3,4,5	3,4,5	3,4,5
26	*Euphorbia hirta* Linn.	Euphorbiaceae	Th	Et	1,2	1,2	3,4	3,4	3,4	3,4
27	*Gynandropsis pentaphylla* Linn.	Capparidaceae	Th	Et	1,2	1,2	3,4	3,4	3,4	3,4
28	*Heliotropium indicum* linn.	Boraginaceae	Th	Et	-	-	-	1,2	3,4	3,4
29	*Ipomoea fistula* Mart.	Convolvulaceae	Th	Pr	2	2,3	1	2,3	2,3,4	2,3,4
30	*Ixora cocinia* Linn	Rubiaceae	Th	Pr	2,3	2,3	3,4	3,4	3,4	3,4
31	*Jussiacia repens* Linn.	Onagraceae	Th	Pr	3,4	3,4,5	1,2	2,3,	2,3,4	-
32	*Justicia diffusa* wild.	Acanthaceae	Th	Et/pr	2,5	2,5	1,2	1,2	2,3	2,3,4,5
33	*Lantana camara* Linn.	Verbenaceae	Ch	Pr	1	-	2	2,3	3	3,4
34	*Leucas aspera* spring	Lamiaceae	Th	Et	1,2	1,2	1,2	1,2	3,4	3,4
35	*Leucas cephalotes* spreng	Liamaceae	Th	Et	3,4	3,4,5	1,2	2,3	2,3,4	2,3
36	*Mollugo hirta* Thumb.	Aizoaceae	Th	Pr	-	-	1	1,2	1,2	2,3
37	*Nerium odoratum* Linn.	Apocynaceae	Th	Et	2,3	2,3	3,4	3,4	3,4	3,4
38	*Ocimum sanctum* Linn.	Lamiaceae	Th	Et	3,4	3,4	3,4	3,4	5	5
39	*Oldenlandia umbellata* Linn.	Rubiaceae	Th	Et	4,5	4,5	1,2	2,3	3,4	-
40	*Oryza sativa* Linn. (Dhan)	Poaceae	Th	Et	-	-	1,2	-	-	-
41	*Parthenium hysterophorus* Linn.	Asteraceae	Th	Et	4,5	-	2	2,3	3,4	3,4,5
42	*Passiflora foetida* Linn.	Passifloraceae	Th	Cl	-	-	1,2	1,2	3,4	3,4
43	*Phyllanthus niruri* Linn.	Euphorbiaceae	Th	Et	1,2	1,2	3,4	3,4	5	5
44	*Phyllanthus simplex* Retz.	Euphorbiaceae	Th	Et	-	-	-	-	-	3,4
45	*Physalis minima* Linn.	Solanaceae	Th	Et	4	-	1	2,3	2,3,4	2,3,4
46	*Polygonum barbatum* Linn.	Polygonaceae	Ch	Pr	-	-	-	-	1,2	1,2
47	*Potamogeton crispus* Linn.	potamogonaceae	Ch	Pr	-	-	1	1,2	2,3	2,3,4
48	*Quisqualis indica* Linn.	Combretaceae	Th	Cl	3	3	3	3	3	3,4
49	*Russelia equisetiformis* Linn.	Scrouphulariaceae	Th	Et	3,4	3,4	3,4	3,4	3,4	3,4
50	*Scoparia dulcis* Linn.	Scrophulariaceae	Th	Et	2	1	2,3	3,4	3,4	3,4
51	*Solanum nigrum* Linn.	Solanaceae	Th	Et	-	-	-	-	3,4	3,4
52	*Solanum surattense* Burn.f.	Solanaceae	Th	Pr	-	-	1,2	1,2	1,2	1,2
53	*Spermacoce hispida* Linn.	Rubiaceae	Th	Et	2,5	2,3,4	2,3	2,3	2,3,4	2,3
54	*Tecoma stans* Linn.	Bignoniaceae	Th	Et	-	-	1,2	1,2	1,2	1,2

55	*Tridax procumbens* Linn.	Asteraceae	Th	Et	1,2	1,2	3,4	3,4,5	3,4,5	3,4,5
57	*Vernonia cinerea* Linn.	Asteraceae	He	Et	-	-	-	1,2,3	3	3,4
58	*Vetiveria zizanoides* (Linn.) Nash.(Khus)	Poaceae	G	Et	-	-	-	-	1,2	1,2
59	*Vinca rosea* Linn.	Apocynaceae	Th	Et	1,2	1,2	1,2	1,2	3,4	3,4
60	*Vitex negundu* Linn.	Verbenaceae	Ch	Pr	3,4	3,4	3,4	3,4	3,4	3,4

Ph – Phanerophytes
Ch – Chameophytes
He – Hemicryptophytes
G – Cryptophytes (or) Geophytes
Th – Therophytes
Et – Erect
Pr – prostrate
Cl–Climbing

1. Germination
2. Vegetative
3. Flowering
4. Fruiting
5. Mature seeds
6. Death of the plant

Table 2:% Composition of Habit Wise Distribution of Identified Plants in the Study Area

Sl. No	Habit	No. of Plants	%
1	Erect	40	66.6
2	Prostrate	11	18.3
3	Climbing	5	8.3
4	Erect / Prostrate	4	6.6

Table 3: Life Form Classification of Identified Plants in the Study Area.

Sl. No		
Sl. No	**Phanerophytes**	*Achyranthes aspera, Calotropis gigantea, Cardiosperum helicacabum* **(5%)**
1	**Chameophytes**	*Cynodon dactylon, Polygonum barbatum, Potamageton crispus, Vitex negundu, Lantana camara.* **(8.3%)**
2	**Hemicryptophytes**	*Boerhaavia diffusa, Vernonia cinerae* **(3.3%)**
3	**Cryphytes (or) Geophytes**	*Cyperus kyllingia, Cyperus rotundus, Vetiveria zizanoides* **(5%)**
4	**Therophytes**	*Ipomoea fistulosa, Jussiaea repens, Justicia diffusa, Leucas cephalotes, Mullugo hirta, Oldenlandia corymbosa, Oryza sativa, Parthenium hysterophorus, Phyllanthus simplex, Physalis minima, Solanum surattense, Spermacoce hispida, Clitoria ternatea, Passiflora foetida, Tridax procumbens, Heliotropium indicum, Euphorbia heterophylla, Dutanta plumieri, Tecoma stans, Phyllanthus niruri, Euphorbia hirta, Croton sparsiflorus, Cleome viscose, Russelia equisetiformis, Quisqualis indica, Acalpha indica, Vinca rosea, Caesalpinia pulcherima, Nerium odoratum, Leucas aspera, Ocimum sanctum, Gynandropsis pentaphylla, Ixora cocinia, Allamenda cathartica, Scoparia dulcis, Annona squamosal,Alternanthera sessilis,Amaranthus spinosus,Amaranthus viridis,Ammania baccifera,Brassica campestris,Chloris barbata,Coccinia indica,Commelina benghalensis,Croton bonplandianum,Eclipta prostrate,Solaum nigrum,* **(78.3%)**

Table 4:% Composition of life form of identified plants

Sl. No	Life Forms	No. of Plants	%
1.	Phanerophytes	3	5
2.	Chameophytes	5	8.3
3.	Hemicryptophytes	2	3.3
4.	Therophytes	47	78.3
5.	Cryptophytes or Geophytes	3	5

DISCUSSION

The phenological observations revealed that just on the set of early monsoon shower in the last week of October and November resulted in the growth of new seedlings and continued throughout December. During the post summer season and in the early monsoon the study area became green and the area was covered by vegetation. The winter annuals show luxuriant flowering and fruiting during December and January. Most of the plants have shown prolonged

reproductive phase and vegetative phase seems to be shortened. Some of the plant species like *Annona squamosa, Tecoma stans, Duranta plumieri, Solanum surattense, Polygonum barbatum and Ammannia baccifera* have never shown flowering and fruiting during the study period. Weeds like *Euphorbia hirta, Parthenium hysterophorus, Tridax procumbens, and Lantana camar*a are frequently observed in the study area.

Life form spectrum:

Raunkiaer[2] proposed a system to classify plant life form based upon protection and degree of renewing bud, which are responsible for renewable of aerial body on the onset of favourable environment conditions. There are five major classes arranged according increased protection of renewing bud. These are phanerophytes (buds naked or covered with scale and positioned high up on the plant), Chamaephytes (buds close to ground), hemicryptophytes (buds hidden under soil), geophytes (or) cryptophytes (buds completely hidden under soil) and therophytes (renewing occurs by seed germination). Presently observed species include 73.3% therophytes 8.3% chameophytes, 5% phanerophytes and Geophytes and 3.3% hemicryptophytes in the study area. Comparison of the presently prepared life form spectrum with that of the Raunkiaer's normal biological spectrum of world revealed that therophytes were higher than the normal spectrum & phanerophytes, chamaephytes, hemicryptophytes and geophytes were found less than the normal spectrum. Therophytes are the indicators of amount of biotic influence on the vegetation and develop especially in the area where vegetation has been distributed by some anthropogenic activities[10,11]. Stressed that higher therophytes are indicators of the magnitude of influence of man and animals on the habitat. [12] prepared the biological spectra of Himalaya vegetation across different altitudes. According to [13] therophytes are the indicators of dry conditions. The high proportion of therophytes in this study is also attributed to human activities [14]. [15] also gave a detailed account of the life forms pattern in the temperate grass lands of Shimla hills, Himachal Pradesh.

The present study revealed that the community is dominated by evergreen species. Various phenological characters of each species are regulated by environmental parameters like temperature, soil, nutrients. Majority of annuals flowers, fruit and produced their seeds in rainy season while fruiting and maturation in a number of perennial are activated during winter. [16,17,18,19] explained identical results. [20] studied the phenology of underground species of tropical moist forest of western Ghat region of Uttara Kannada district in South India and concluded that the herbs showed the flowering and fruiting concentration in a single peak during monsoon and post monsoon study, which also supports the present study. Rains trigger the phenological events. Photodynamic analysis reveals that various phenophases from sprouting to seed maturation have phenological calendar, which begins with the advent of the first shower of rain. The episodic growth of vegetation in rainy season illustrates it to be the peak growth period for the majority of plants. Most of the workers concluded that the progression of temperature and moisture conditions influence vegetative growth[21, 22, 23]. Analysis of phenological records can provide an effective means for examination of phenological trends with time [24] and assist with gaining insight into the responses of species to climate change[25]. The differential responses of species and phenophases to changing temperatures may be attributed to other non-temperate-related ecological factors [26] such as photoperiod, plant functional type, genetic regulatory systems, demography and an adaptability etc.Biological spectrum may be materially changed due to introduction of therophytes like annual weeds due to biotic influences like agricultural practices, grazing and other biotic disturbances. The dominance of therophytes (78.3%) is due to biotic interference coupled with heavy grazing pressure.[27] studied the biological spectrum of grazed and ungrazed vegetation in Gambhar catchment and observed 7.8% increase in therophytes in the grazed site than ungrazed site. Similar is true for present study area. [28] found therophytic dominance in the grasslands of Shimla hills because of heavy grazing. [29] presented Thero-nano phanerophytic biological spectrum of the flora of Shajahanpur district, Uttar Pradesh. The dominance was again because of grazing in the area. In the climax vegetation or even in the developing communities, dominant species are in equilibrium with their environment. Thus, biological forms are related to the environment. Biological spectrum is also an indicator of the prevailing environment [30]. The preponderance of therophytes in the area may be due to the reason that the therophytes are the ephemerals which survive adverse seasons in the forms of seeds and predominantly found in extremes of dry, hot or cold conditions. The higher percentage of therophytes indicates a pronounced biotic or anthropogenic effect which maintains the vegetation open for further invasions of annuals with the result good phanerophytic flora may be very much reduced in course of time[31]. reported that overgrazing tends to increase percentage of therophytes through introduction and spread weedy species. The present findings are in conformity with these findings.

Phenological studies of the selected area have shown the greatest seasonality is leafing and flowering [32,33,34,35]. These activities may be controlled in some plant species by the highly seasonal pattern of rain fall, flowering although cause and effect have not been demonstrated for all species observed to respond in this way [36]. Floral initiation frequently occurs at the end of the vegetative growth and anthesis occurs sometime after[37, 38].

Higher percentage of the therophytes which was found to be more adaptive and survive in adverse season in the form of seeds, are predominantly found in dry, hot or cold conditions. According to [39] the predominance of therophytes indicates warm climate. [40] assigns the dominance of therophytes in cold regions to biotic interference includes deforestation, intensive utilization of land for cultivation and over grazing etc.

CONCLUSION

Different phenological responses among species are likely explained by genetically controlled factors that are inherent to different species. Such differences may cause uncertain ecological consequences with implication to ecosystem stability and function in an environment. However, these phenological parameters are only an approximation of the true

biological growth stages. This is mainly due to the limitation of current space based remote sensing, especially the spatial resolution and the nature of vegetation index. These phenological differences may in turn be related to climatic factors rather than to selection action directly on the timing of flowering. Although flowering time did affect the reproductive output of individual flowers, differences among individual plants in reproductive output are probably more closely till linked to flower production and with pollinator-mediated seed production than to the differing flowering phenologies. The study gives an idea about the time span of different life phases in the species. It clearly indicates that most of the phenological events in observed plants are induced by photo period and temperature. This information may be used as base line for further evaluation of phenological variations in response of the climate change

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