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Phenological Behavior of Woody Elements in Sangla Valley of Kinnaur (Himachal Pradesh)

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Abstract

The investigation was undertaken to study the phenological behavior of woody elements in Sangla valley, Kinnaur, Himachal Pradesh by selecting 12 different quadrates / transects (25 × 500 m) in longitudinal direction between an altitudinal range of 2,700 to 3,535 m above mean sea level. Monthly observations from July to next year June of all the woody elements present in all the transects were carried out to observe the phenological changes, viz., bud sprout, young leaf stage, mature leaf stage, flowering stage, seed maturity and seed fall / leaf/ needle fall. The study revealed that variation in different phenophases of the vegetation during the same and different growing seasons was due to variation in climatic conditions, altitudinal variations, aspect, genetic alterations and original behavior of the different plant species. The study is quite useful for studying the reproductive biology and breeding behavior of a species and also in developing a calendar for the vegetative activities of the woody elements. It is also helpful in knowing the abrupt changes that occur in different plant communities in different habitats.

Key words : Woody elements, Phenological behavior, Phenophases, Variations, Reproductive biology.

Indian Himalayas spread approximately 2,500 km from northwest to southeast along with its extensions in northeastern parts of India with a breadth ranging from 250 to 450 km. The impact of terrain, diversity and altitudinal variation with concurrent changes in temperature and precipitation has created a unique ecosystem of diverse habitats and species associations, one of the richest in the world. The ecological changes and diversity of natural vegetation and associated fauna at any place in the Himalayas are determined by the interactions of vertical, transverse and longitudinal axis (1). The vertical axis by the altitude is dependent on the effect of temperature and moisture, the traverse axis cutting across the main land is determined by topography causing decreased annual precipitation and extreme temperature fluctuations between front and interior ranges. The longitudinal axis parallel to the ranges is determined by a general geographical trend of decreasing monsoon precipitation and increasing winter snowfall, southeast to northeast. A greater variation in aspect, slope and altitudinal zonation has resulted in abrupt changes in plant communities and as such small areas may comprise a variety of habitat types (2). The descriptive study of the behavioral characteristics of organism in relation to their environment is termed as phenology. According to Leith (3), phenology is generally described as the art of observing the phases of the life cycle or the activities of the organisms as they occur through the year. These studies permit a calendar to be constructed for the vegetative activity of the plants especially the periods of leaf shedding, flowering and fruiting superimposed on civil calendar. The study of leafing, flowering and fruiting is a pre-requisite for studies on the reproductive biology and breeding systems of a species.

Methods

The studies were restricted to the main Sangla valley in district Kinnaur (Himachal Pradesh) from village Chansu to village Chitkul. Complete survey of the area (both left as well as right banks of the river Baspa) was carried out to select 12 different sites for laying of permanent transects.

In total, 12 transects (25 × 500 m) were marked in longitudinal direction at different sites (Table 1).

Monthly observations from June to July of all the species present in all the transects was carried out to observe following phenophases : 1=Bud

Table 1. Depicting village/area of marked transects with average altitude and aspects.

Transect number	Village/Area	Average altitude (m)	Aspect
1	Chansu (Sering)	2,700	Eastern
2	Chansu (Chiagang)	2,755	Eastern
3	Kamroo (Ragon)	3,151	Western
4	Kamroo (Rangon)	3,155	Western
5	Kamroo (Thindey)	3,150	North-western
6	Azad Kashmir	2,930	Northern
7	Batseri (Thano)	2,995	Northern
8	Raksham (Nangko)	3,195	Western
9	Raksham (Nangko)	3,280	Western
10	Chitkul (Rangon)	3,535	Northern
11	Chitkul (Rangon)	3,495	Northern
12	Chitkul (Rangon)	3,510	Northern

sprout stage, 2=Young leaf stage, 3=Mature leaf stage, 4=Flowering stage, 5=Seed maturity stage, 6=Seed fall/Leaf/Needle fall stage, and D=Dormant/ Leafless stage.

Results and Discussion

Phenology is generally described as the art of observing the life cycle phases or the activities of the organism as they occur through the year, as we can say that the descriptive study of the behavioral characteristics of organism in relation to their environment is termed as phenology. Phenology being the quantitative measure of the life or specific phenophases and their values with regard to ecosystem analysis, lies particularly in the understanding they provide of plant responses to climate (3).

In present study, the different phenophases of all the species in various transects is depicted in cumulative (Table 2) and synthetic phenological diagram constituted from different species wise phenophases (Fig. 1). It was found that the similarities and differences both on qualitative and quantitative terms, there was no single phenological stage which was not being overlapped by proceeding or the next stage. Thus there was no major and abrupt change from one phenophase to another. The quantitative differences arise due to the different types of areas supporting different types of species and association, due to variation in supporting system viz., the soil characteristics, altitude, slope.

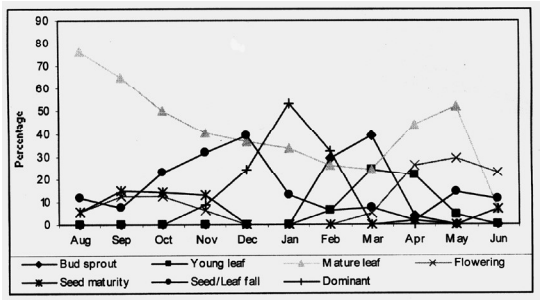

Figure 1. Synthetic phenological diagram of different transects in study area during July to June.

On the other hand, the similarities present within the species in different transects are mainly due to the initiation of growth and active vegetative growth during the start of growing season, i.e., February / March. The flowering phase sets in from March onwards and lasts till June / July. However, late flowering was observed in conifers. This flowering stage is overlapped by seed maturity stage confined from June to January in different species. Similarly, leaf fall stage starts from April onwards in conifers and the peak overall leaf fall is observed during November and December especially in broad leaf species. The leaf less stage in broad leaves ; remain till the initiation of active growth period during next year i.e., in March (Table 2, Fig. 1).

Blaisdell (4) and Sauer (5) have shown that temperature influences plant development and presumably through its effect on metabolic rate through the alternating diurnal temperatures (6). Similar was the case in present investigation, where bud sprout was initiated during March / April when the atmospheric temperature starts rising. Further more the overall phenological differences between the different transects in present study might be because of temperature integral at each site, which did not reach the corresponding requirement of the species as also reported by Flower and Tiedemann (7). Thus variation in flowering behavior can also be attributed to the different altitudinal ranges. Heslop-Harrison (8) and Evans and Knox (9) found that day length controls the expression of flowering behavior. Jackson (10) gave the concept that phenological progression fol-

Table 2. Cumulative phenophases of different species of occurrence in all the transects. Where 1 = Bud sprout stage ; 2= Young leaf stage ; 3 = Mature leaf stage ; 4 = Flowering stage ; 5 = Seed maturity stage ; 6 = Seed fall / Leaf / Needle fall stage ; D = Dormant / Leafless stage.

Species	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Trees												
Abies pindrow	3	3	3	3, 4, 5	3, 6	3	3	3	1, 3	3,4	3, 5, 6	3, 6
Aesculus indica	3	3	3, 4, 5	3, 4, 5, 6	3, 6	3, 6	3	3	1, 2, 3	3,4	3, 4	3, 5
Alnus nitida	3	3	3, 4, 5	3, 4, 5, 6	3, 5, 6	D	D	1	2	3	3, 6	3
Betula utilis	3	3	3, 4, 5	3, 6	3, 6	D	D	D	1, 2	3, 4	3, 4	3, 5
Cedrus deodara	3	3, 4	3	3	3, 6	3	3	1, 3	2,3	3,6	3,6	3, 4, 6
Celtis australis	3	3	3	3	3, 4, 5	3, 6	D	D	1	2, 3	3, 4	3
Juglans regia	3	3	3, 4, 5	3, 6	3, 6	6	6	1, 2	2	3, 4	3, 4	3, 4
Juniperus recurva	3	3	3	3	3, 5	3, 6	6	3	1, 3	2, 3	3, 4, 6	3,4
Picea smithiana	3	3	3	3	3, 4	3, 6	3	3	1, 3	2, 3, 4	3, 4, 6	3, 6
Pinus wallichiana	3, 6	3	3	3, 6	3, 6	3	3	3	3, 4	3, 4	3, 4, 6	3, 6
Populus ciliata	3	3	3	3	D	D	D	D	1, 6	2, 3, 4	3, 4	3
Prunus arminica	3, 5	3, 6	3, 6	3, 6	D	D	D	1	2, 3	3, 4	3	3
Prunus persica	3, 4, 5	3, 6	3, 6	D	D	D	D	1	1, 2	3, 4	3	3
Pyrus pashia	3, 6	3	3, 4, 5	3, 6	6	D	D	1	2	3, 4	3	3, 5
Quercus dilatata	3, 4	3	3	3	3, 5	3, 6	3	1, 2, 3	3, 4	3, 4, 5	3, 6	3, 6
Rhododendron campanulatum	3, 4	3, 5, 6	3	3	3	3	3, 6	3, 6	3, 6	1, 3	2, 3	3, 4
Salix elegans	3, 5	3, 6	3, 6	3, 6	D	D	D	1	2	3	3, 4	3, 4
Shrubs												
Berberis aristata	3	3	3	3, 4, 5	3, 6	3, 6	D	D	1	2	2	3
Desmodium tiliaefolium	3	3	3	3, 4, 5	3, 6	6	D	D	1	2, 3	3, 4	3, 4
Hippophae rhamnoides	3	3	3	3, 6	3, 6	3, 6	D	D	1	2	3, 4	3, 4
Myrsine semiserrata	3	3	3	3	3	3	3, 6	3, 6	3, 6	1, 2, 3	3, 4	3
Prinsepia utilis	3	3	3	3	3, 4, 5	6	D	D	1	2	3, 4	3, 4
Rhus cotinus	3	3	3	3, 5, 6	5, 6	6	D	D	1	2, 3, 4	3	3

Table 2. Continued.

Species	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
						Shrubs						
Rosa moschata	3, 4	3, 4	3	3, 5	3, 6	6	D	D	1	2, 3, 4	3	3
Spiraea lindleyana	3	3	3	3, 4, 5	6	6	D	D	1	2	3, 4	3, 4
Viburnum cotinifolium	3, 4	3, 5	3, 5	3, 6	3, 6	D	D	1	2	3	3	3, 4

lowed cumulative heat sums. Wang (11) presented a historical account of development of phenological observation and the thermal heat index.

Mehar-Homji (12) is of the opinion that to judge the characteristics of aridity or humidity of a region, five criteria may be proposed viz., climate, ephemonic, floristic, vegetational and agronomic. Frankie et al. (13) and Medway (14) describe several types of variation in the timing and duration of leaf, flower and fruit production. According to them the northern collection started growth first, they were gradually followed by more southerly sources and plants from the most southern reaches of the range started growth last in sugar maple (*Acer saccharum* Marsh). Phenological events are also influenced by the biotic influences of association, species as well as by the climatic factors, stand density (light) ; and site quality influences the flowering and fruiting of teak e.g., shallow soils induce early flowering (15).

Thus it can be concluded that the variations in different phenophases of the vegetation during the same and different growing seasons may be due to climate variations, altitudinal variations, aspect, genetic alterations and the original behavior of the different plant species (6), as also observed in the present study.

The phenological observations depicted that with the advent of spring season during March, both leaf and bud initiation was observed in maximum of the species. In *Abies pindrow, Betula utilis, Celtis australia, Juglans regia, Picea smithiana, Pinus wallichiana* and *Rosa moschata,* flowering was observed during April.

In pines, seed fall was observed in October and November, while in *Betula utilis,* complete leaf shedding and seed dispersal was also during October and November. Thereafter, the deciduous species remained leafless for nearly three winter months. Other tree species like *Quercus dilatata* showed leaf fall during April to June and seed fall during November and December. *Juniperus recurva* was found to possess bud initiation during March and April, flowering during May and June, seed fall in December and January with major leaf fall during July and August. However in *Salix elegans* fresh leaves were initiated during February and March ; flowering during May, seed dispersal during August to October with complete leaf fall before November. In *Populus ciliata,* it was observed that it remained leafless from December to February, new leaves emerged during March and April, seed dispersal during July / August and complete leaf fall during November / December while in case of *Alnus nitida*, flowering was during September and seed fall in December, with major leaf fall in April and May. Although *Rhododendron companulatum* remained green throughout the year, but fresh leaves appeared during April and May, with flowering during June and July and seed dispersal during December onwards.

In shrubs, in general, it was observed that in *Berberis aristata*, *Rosa moschata* and *Viburnum cotinifolium*, seed and leaf fall was observed during November and December, and fresh leaves appeared after the winter season. *Myrsine semiserrata* was found to be of evergreen in nature, but new leaves emerged during March and April, flowering was in May, while fruit ripened during December and remained attached to the plant, which is mostly consumed by birds during winter months. However, in *Desmodium tiliaefolia, Hippophae rhamnoides* and *Spiraea lindleyana*, it was observed that they remained leafless during winters, flowering was during May, leaf

and seed fall during October and November excepting in *Hippophae rhamnoides*, where fruit remained on the plant till January.

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