CHAPTER-7

PHENOLOGY

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Phenological information on different floristic elements of a place helps to understand the nature of a vegetation in a much better way. It is intimately related to the prevailing climatic conditions of a place, mainly water relations, temperature cycle and photo-periods. It is interesting to note how different species react to different phases of climatic cycle of a place within its range of distribution and to observe how plants of different habit groups, e.g. *annuals, geophytes, shrubs, climbers,* etc passes through different seasons of the year and completes their annual/life cycles.

Pattern of phenology varies greatly even within same habit groups or similar type of vegetation. This indicate different types of responses by different species to any environmental set-up. Therefore, an understanding of phenology of a species expresses the gradual changes of its phenological conditions throughout the year.

Extensive works on phenology of different species and vegetation have been done in different corners of the world (Harper 1906; Janzen 1967; Lieth 1970, 1974; Lieth and Radford 1971, Daubenmire 1972, Frankie *et al.* 1974, Putz 1979). In India, though the scope and need of this type of work is extremely high, only very little works have been done in some isolated patches. Ramakrishnan and his co-workers in North-East India (Booj and Ramakrishnan 1981; Shukla and Ramakrishnan 1982), Kaul and Raina (1980) in Srinagar, Ralhan *et al.* (1985) in Kumaun and Sundriyal (1990) in Garwal studied the phenology of woody plants, mainly trees. Sivaraj and Krishnamurthy (1989) have studied flowering phenology in the vegetation of Shervaroys in South India.

Though the flora of Eastern Himalaya is extremely rich and diverse with numerous economically important plants (Das 1995, Das and Chanda 1992), which was studied by numerous stalwarts in Botany including J. D. Hooker, C.B. Clarke, Buchanal Hamilton, J.S. Gamble, A.S. Cowan and others, is yet to have a record of such works except a flowering calendar of 1052 species of temperate angiosperms (Das and Chanda 1987).

During a recent survey of angiospermic climbers in Darjeeling and Sikkim Himalayas (Samanta and Das 1995) phenology of some common climbers have also been studied. The present chapter deals with such information. Climbers are the most

sensitive group of plants which are generally worst sufferer of any type of interference with the vegetation of an area. So, before framing up of any strategy for the conservation of this vulnerable group of plants their natural habitats are to be preserved with topmost priority.

From the records of the survey of climber-flora of Darjeeling and Sikkim Himalayas, during 1994-1996 (Samanta and Das 1995) phenological studies on 68 of such species have been carried out. These plants are representing various altitudinal zone starting from the foot-hill region to the 3200m altitude. Selected plants include annuals, geophytes, shrubs and liana-which are supposed to show differential responses to the climatic cycle of their habitat.

Following aspects were recorded during the survey:

i. Emergence of seedlings

ii. Initiation of growth on breaking the dormancy

iii. Type of dormancy breaking

iv. First flush of leaf

v. Subsequent leaf-flushes

vi. Appearance of floral-buds

vii. Flowering period

viii. Ripening of fruits

ix. Shading of leaves/Initiation of Dormancy

x. Mode of pollination

xi. Method of seed dispersal

Marked habitats for the selected plants were visited regularly and the observations on above aspects were recorded.

Type of germination were recorded for 24 species of plants but all are in the laboratory conditions though with normal soil in earthen pots.

For the record of flowering period, the entire range, i.e. from initiation to completion were recorded.

Table-7.1 Phenological events of some angiospermic climbers of Darjeeling and Sikkim Himalayas

Abbreviations Used: **Habit**: CA= Annual Climber; CG= Geophytic Climber; CH= Herbaceous Climber; CS= Shrubby Climber; L= Liana ; **Method of seed dispersal**: Ar= Air; Br= Bird; Mc= Mechanical; Wn= Wind; **Mode of pollination**: A= Anemophilous; E= Entomophilous; Am= Amphiphilous; **Months**: Jan= January; Feb= February; Mar= March; Apr= April; Jun= June; Jul= July; Aug= August; Sep= September; Oct= October; Nov= November; Dec= December; **Pattern of leaf fall**: DC= Deciduous; EG= Evergreen; SEG= Semievergreen; DT= Death; DAP=Death of aerial part; **Type of breaking dormancy**: Fl= Formation of flower bud; Lf= Enlargement of leaf bud; Sht= New shoot appearance; **Miscellaneous**: Cont= Continues; G= Germination; NR= Not Recorded

Name of the plants	Habit	Emergence of seedling	Initiation of growth or breaking of dormancy	Type of breaking dormancy	Ist flush of leaves	Subsequent leaf flush	Appearance of flower bud	Flowering period	Ripening of fruit	Shading of leaves/ death	Mode of pollination	Method of seed dispersal	Pattern of leaf fall
Abrus pulchellus	CS	May-Jun	Apr-May	Lf	Apr-Jun	Cont	Jul	Aug-Oct	Nov-Dec	Dec-Jan	E	Mc	DC
Actinidia callosa	L	NR	Mar	Lf+Fl	Apr	Cont	Apr	May-Jul	Ovt-Nov	Dec-Jan	E	Mc	DC
A. strigosa	L	NR	Mar	Lf+Fl	Mar-May	Cont	Apr	May-Jun	Oct-Dec	Dec-Jan	E	Mc	DC
Ampelocissus sikkimemsis	CS	May-Jun	Apr-May	Lf+Fl	Apr	Cont	Apr	Apr-Jul	Nov-Dec-	NR	E	Br	EC
Argyreia roxburghii	L	Jun-Jul	Mar-Apr	Sht	May-Jun	Cont	Jul	Aug-Sep	Oct-Dec	Nov-Jan	A/E	Br/Rat	DC
Aristolochia griffithii	L	NR	Mar	Lf+Fl	Apr	Jul	Mar	Apr-May	Jun-Aug	Nov-Dec	E	Mc	DC
A. indica	CS	May-Jun	Apr-May	Lf	Apr-May	Aug	Jul	Aug-Oct	Oct-Dec	Nov-Dec	E	Mc	DC
A. tagala	CS	NR	Apr-May	Lf	Apr-May	Aug-Sep	Apr	May-Jun	Oct-Nov	Dec-Jan	E	Mc	DC
Artabotrys hexapetalus	L	Jun-Jul	Cont	NR	NR	Cont	Mar	Apr-Jul	Sep-Jan	NR	E	Br	EG
Aspidopterys	L	NR	Mar	Lf	Mar-	Cont	Jun	Jul-Sep	Oct	Dec-	E	Mc	SEG

Contd....

wallichii					May					Jan			
Bauhina vahlii	L	NR	Mar	Lf	Apr-May	Cont	Apr	Jun	DEc-Feb	Dec-Jan	E	Mc	DC
Cajanus scarabaeoides	CA	Apr-May	Cont	G	NR	Cont	Jun	Aug-Oct	Oct-Nov	Nov-Jan	E	Mc	DT
Celastrus monospermus	CS	NR	Feb	Lf	Mar-Apr	Aug	Apr	Apr-Jun	Aug-Sep	Nov	E	Mc	SEG
C. paniculatus	CS	NR	Feb	Lf	Mar	Aug-Sep	Mar	Jun-Jun	Sep-Dec	Dec-Jan	E	Mc	DC
C. stylosus	CS	NR	Feb	Lf	Mar-Apr	Jul-Aug	Apr	Mar-May	Jul-Oct	Dec	E	Mc	DC
Coccinia grandis	CA	May-Jun	May	Lf	May	Cont	Jun	Jun-Dec	Aug-Dec	DEc-Apr	E	Br	DC
Combretum flagocarpum	CS	NR	May	Lf+Fl	May	May	May	May-Aug	Nov-Dec	Feb-Mar	Am	Ar/Wn	DC
Cuscuta reflexa	CS	NR	Jun	NR	Jun	Cont	Sep	Sep-Dec	Dec-Apr	Apr	E	Br	NR
Cynanchum corymbosum	CS	NR	Apr-May	Lf	May	Aug	Aug	Sep-Oct	Nov-Jan	Jan-Feb	E	Mc	SEG
Deeringia amaranthoides	CS	Jun-Jul	Apr	Lf	May	Cont	Sep	Nov-Dec	Nov-Jan	Dec-Jan	A	Mc	DC
Dioscorea belophylla	CG	May-Jun	Apr	Sht	May	Cont	Aug	Aug-Sep	Dec-Jan	Dec-Jan	A	Ar/Wn	DAP
D. bulbifera	CG	May-Jun	May	Sht	May	Cont	Jun	Jul-Oct	Oct-Feb	Dec-Jan	A	Ar/Wn	DAP
D. pentaphylla	CG	May-Jun	Apr-May	Sht	May	Cont	Jul	Jul-Sep	Nov-Dec	Nov-Dec	A	Wn	DAP
Diplocyclos palmata	CA	May-Jun	Cont	G	Cont	Cont	Aug	Aug-Oct	Sep-Jan	Dec-Jan	E	Br	DT
Elaeagnus conferta	CS	Jun-Jul	Apr	Lf	May	Cont	Oct-Nov	Oct-Nov	Mar-May	Dec-Jan	E	Mc	SEG
Entada rheedii	L	Dec	Feb	Lf+Fl	Mar	Mar	Mar-Apr	Feb-Jun	Oct-Dec	Dec	E	Mc	DC
Gynostemma pentaphylla	CS	May-Jun	Apr-May	Lf	May-Jun	Cont	Jun	Jun-Oct	Sep-Nov	Nov-Dec	E	Br	SEG
Heterosmilax japonica	CS	NR	Apr	Lf+Fl	Apr-	Jul-Aug	Apr	Apr-Jun	May	NR	E	Mc	DC

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Periploca calophylla	CS	-	Apr	Lf	May	Cont	May	May-Jun	-	-	E	Ar/Wn	SEG
Piper longum	CS	Jun	Apr	Lf	Apr	Cont	May	May-Aug	Nov-Feb	Nov-Dec	A	Wn	SEG
P. suipiqua	CS	NR	Apr	Lf+Fl	Apr	Cont	Apr	May-Aug	Aug-Jan	Nov-Dec	A	Wn	DC
Pueraria phaseoloides var. *subspicata*	CH	Jun	May	Sht	May	Cont	Aug	Nov	Dec	Dec-Feb	E	Mc	DC
P. sikkimensis	L	NR	Feb	Fl	Mar	Cont	NR	Feb-Mar	Apr-Jun	Nov-Dec	E	Mc	DC
Rubus acuminatus	CS	NR	Apr	Lf	May	Jun-Sep	Jun	Jul-Sep	Aug-Dec	Oct-Nov	E	Br	DC
Sabia campanulata	CS	NR	Mar	Lf+Fl	Apr	Cont	Apr	Apr-Jun	May-Aug	Nov-Dec	E	Br	DC
Schisandra grandiflora	CS	NR	Mar	Lf+Fl	Apr	Jun-Jul	Apr	Apr-Jun	Sep-Oct	Nov-Jan	E	Br	DC
Senecio araneosus	CS	May	May	Lf	May	Aug	Sep	Oct-Dec	Dec-Jan	Dec-Feb	Am	Wn	DC
S. wightianus	CS	NR	Apr	Lf	May	Cont	Sep	Oct-Dec	Dec-Mar	Dec	Am	Wn	DC
Terastigma obtectum	CS	NR	Mar	Lf+Fl	Apr	Cont	Apr	Apr-May	Aug-Oct	Nov-Jan	E	Br	DC
T. rumicispermum	CS	May	Apr	Lf	Apr	Cont	Apr	Apr-Jun	Sep-Nov	Nov-Feb	E	Br	DC
T. serrulatum	CS	Jun	Apr	Lf	May	Cont	May	Jun-Oct	Oct-Mar	Nov-Jan	E	Br	DC
Thlandiantha cordifolia	CG	May	Apr	Lf	Apr	Cont		May-Aug	Jun-Oct	Nov-Dec	E	Br	DC
Thunbergia coccinea	CS	May	Mar	Lf	Apr	Cont	Jun	Jul-Sep	Oct-Mar	Nov-Jan	E	Br	DC
T. fragrans	CS	Jun	Mar	Lf	Mar	Cont	Jun	Jul-Nov	Oct-Feb	Nov-Jan	E	Br	DC
Trichosanthes cordata	CG	May	Mar	Sht	Apr	Jul-Aug	Jun	JUn-SEp	Sep-Dec	Dec-Jan	E	Br	DC
T. dioica (wild)	CG	NR	Mar	Sht	Mar	Cont	Mar	Apr-Jun	NR	Nov-Dec	E	Br	DC

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T. lepiniana	CH	May	Apr	Sht	Apr	Jun	Jun	Jul-Aug	Aug-Nov	Nov-jan	E	Br	DC
Vicia hirsuta	CA	Jan	Cont	G	Cont	Cont	Jan	Jan-Mar	Feb-Apr	Mar-Apr	E	Mc	DT
V. sativa	CA	Jan	Cont	G	Cont	Cont	Jan	Jan-Mar	Feb-Apr	Mar-Apr	E	Mc	DT
Zanthoxylum oxyphyllum	CS	May	Apr	Lf+Fl	Apr	Cont	Apr	Apr-May	May-July	Nov-Jan	E	Mc	DC

7.1. RESULTS AND DISCUSSION

The phenology of almost all the climbers studied for the purpose showed a nearly similar response to the local climatic conditions. The climatic cycle in this part can be divided into two main parts (i) Summer-Monsoon and (ii) Winter. From the end of February, temperature starts rising gradually but very slowly specially in the high altitude. At many places the snow cover continued upto the end of April or even upto May. In the foot-hill region, though there is no snowfall but the winter is quite severe.

Out of the 68 species (Table 7.1) studied for phenological information only two annuals (*Vicia hirsuta and V. sativa*) can be appear (on germination of naturally dispersed seeds) during January, grow fast, initiate flowering in 5-8 leaved condition and by March-April all these plants die along with the ripening of their fruits.

Other annuals in the list bypass the winter seedlings generally appear during March to June most of them completes their life cycle with the onset of winter. In most of the years, there is some amount of rainfall during March-April, which helps the seeds of these plants to germinate. Some such plants start flowering even during June and produce almost mature fruit by the end of the same month. However, most of them starts flowering in August and dies during December-January.

Geophytic climber too respond in the similar manner as annuals did. Due to the favourable position of the watertable and early rain most of these plants start sprouting during April to May and after that they continue their vegetative growth at a very fast rate. However, the initiation of flowering in these plants are species specific. While *Trichosanthes cordata* and *T. lepiniana* flowering starts during June-July and continue upto the September, the wild form of *T. dioica* flowers during April to July. On the other hand, the flowering period of *Thladiantha cordifolia* is May to August. Species of *Dioscorea* starts flowering during July-August. Whatever the difference may exist in the flowering period of these geophytic climbers, they complete their fruit ripening with the onset of winter and then wither away their aerial parts mainly during November-December.

Liana, shrubby climber and other herbaceous climbers with perennial stem-all behave almost in the similar fashion. While plants from higher altitude break their dormancy during April-May, it is generally one-month earlier for the plants growing in the foot-hill region. after awakening, buds in different species grows at different speed but they generally produce the first flush of leaves with a month. However, there are some differences in the mode of breaking dormancy in these plants.

While only one (*Pueraria sikkimensis*) species produce flower at the begining which is followed by leaves. But, in majority of the cases (35 spp) the first flush is with leaves only and in another set of 13 species produce flower buds along with the first-leaves. So, these last 13 species along with *Pueraria sikkimensis* are early flowering plants and their subsequent vegetative growth continue for a longer period, till the effect of cold temperature hamper its process.

Flowering initiate in other plants (35 spp) mainly during July-August. However, in the most of the plants fruit ripening take place during November to January. While fruits are ripening, leaves are also start falling with approach of winter. All sides gradually take a deserted look. Wiry stems of climbers bearing winter buds at nodes or at branch tips are now clearly visible because most of the supporting plants, mainly in the high altitude are also deciduous.

Out of these 68 species only three are evergreen (*Ampelocissus sikkimensis, Artabotrys hexapetalus, Paederia scandens*) and 11 species semievergreen. While 41 species are deciduous there are 6 species of geophytic climbers where the aerial part dies with the onset of winter.

From this phenological data of 68 species of climbing angiosperms from Darjeeling and Sikkim himalayas one can easily realise the chilling effect of winter when most of climbing plant either die or kill their aerial part or stop their growth to pass in a sleeping period of 3-4 months.

On the other hand, after winter all these plants immediately try to regain the growth activity. So, the life style of all these climbers are highly at per with the local environmental conditions.

7.2 FLOWERING AND FRUITING CALENDAR OF SOME ANGIOSPERMIC CLIMBERS OF DARJEELING AND SIKKIM HIMALAYAS

The regularity in the timing of flowering and fruiting in plants completes its life-cycle and are very much species specific. It is also adjusted in such a manner that seeds are released in proper time so that their germination is not hampered. This biological clock is nicely adjusted with the local seasonal changes.

The study of flowering and fruiting periods of plants are quite important from various angles which include the fields of cytogenetics, breeding, palynology, chemical aspects of respiratory allergy, etc. It is also important for the study of the appearance of various insect or other pollinator species, migration of various animals including birds, etc.

Availability of flowers and fruits also extremely important in taxonomical works because floral characters are very stable and also those are mostly good characters. And, various species of plants always do not grow in easily accessible or near by places and for collecting those plants numerous visits can not be arranged for a chance of getting a plant in flower.

Study of pollen flora of a particular region is also very important because pollen related allergy is the main cause of numerous respiratory diseases like bronchitis, asthma, etc (Chanda *et al.* 1972; Ciampolini *et al.* 1981; Sheldon *et al.* 1967; Halmont 1607; Vanselov 1967; Wodehouse 1971). Knowledge on the flowering calendar of a places will certainly be helpful in the serological treatment of these diseases, a plant in flower means its pollen might be in air and may cause respiratory allergy.

Realising all these importantance, flowering and fruiting of angiospermic climbers in Darjeeling and Sikkim Himalayas have also been recorded during survey.

Repeated visits to habitats of various climbing species and observing some plants in garden condition are the main technique of studying flowering calendar. The method of studying fruiting calendar is also quite similar where the time taken from the initiation of ripening till the completion of the ripening of all fruits has been treated as fruiting period for a species.

Some variation in flowering and fruiting period have been noted in a few plants with the change of altitude of their habitats, where a total range of period has been presented.

Das and Chanda (1987) has been published a flowering calendar of angiosperms growing in temperate regions of Darjeeling and Kurseong which also included a large number of climbers. Kundu *et al* (1981), Bhujel (1996) have also presented flowering calendar of many plants of Darjeeling region. But there is no such publication available on the plants of Sikkim. The present calendar presenting the entire fruiting part extra to the earlier publications. At the same time, it enlisted many plants new and covering a much wider region.

Table 7.2. : Flowering and fruiting calendar of the angiospermic climbers of Darjeeling and Sikkim Himalayas.

Name of plants	Habit	Flowering Period	Mode of pollination	Fruit rip. period
Abrus pulchellus	CS	Aug-Oct	E	Nov—Dec
Acacia intsia	CS	Jun-Jul	E	Oct-Feb
Aconogonum molle var. *molle*	CS	Sep-Oct	Am	Oct-Nov
Actinidia callosa	L	May-Jul	E	Nov-Dec
A. strigosa	L	May- Jun	E	Oct-Dec
Adenia cardiophylla	L	May- Aug	E	NR
Aganosma gracilis	CS	May-Jun	E	NR
Ampelocissus barbata	CS	May-Jun	E	Jun-Jul
A. sikkimensis	CS	Apr-Jul	E	Nov-Dec
Argyreia roxburghii	L	Aug- Sep	E	Oct- Dec
Aristolochia cathcartii	CS	May-Jun	E	Apr-Aug
A. elegans	CS	Sep-Dec	E	Dec-Jan
A. griffithii	L	Apr-May	E	Jun-Aug
A. indica	CS	Aug-Oct	E	Oct-Dec
A. nakaoi	CS	Mar-Jun	E	Jun-Aug
A. saccata	L	(Mar)	E	Jun-Aug
A. tagala	CS	May-Jun	E	Oct-Nov
Artabotrys hexapetalus	L	Apr-Jul	E	Sep-Jan
Asparagus racemosus	CA	(Sep)	A	Sep-Nov
Aspidopterys nutans	CS	NR	NR	Oct-Nov
A. wallichii	L	Jul-Sep	E	(Oct)
Basella alba	CA	Sep-Oct	A	(Nov)
Bauhinia scandens	L	Sep-Oct	E	Dec-Mar
B. vahlii	L	Jun	E	Dec-Jan
Biswarea tonglensis	CA	Jun-Oct	E	Sep-Dec
Blumea riparia	CS	Oct-Nov	Am	Nov-Dec
Butea parviflora	CS	Jul-Oct	E	Dec-Mar
Caesalpinia bonduc	CS	Aug-Sep	E	Sep-Nov
C. cucullata	CS	Oct-Dec	E	Jan-Mar
Cajanus scarabaeoides	CA	Aug-Oct	E	Oct-Apr
Calamus flagellum	CS	NR	NR	May-Jun
Cardiospermum halicacabum	CA	(Apr)	E	(Dec)
Cayratia japonica	CS	Mar-May	E	Jul-Oct
Celastrus monospermus	CS	Apr-Jun	E	Aug-Sep

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C. paniculatus	CS	Jun-Jul	E	Sep-Dec
C. stylosus	CS	Mar-May	E	Jul-Oct
Ceropegia longifolia var.	CA	Jul-Sep	E	CA
longifolia	CA	Jul	E	Oct-Jan
var. *pubescens*	CA	Jun-Oct	E	Oct-Jan
Chonemorpha fragrans	CS	May-Jul	E	Oct-Feb
Cissampelos pareira	CS	May-Sep	A	Sep-Oct
Cissus assamica	CS	Jun-Aug	E	Sep-Jan
C. javana	CS	Jun-Jul	E	Sep-Nov
C. repens	CS	Jul-Aug	E	Sep-Jan
Clematis acuminata	CS	Sep-Dec	E	Dec-Apr
C. buchananiana	CS	Jul-Nov	E	Oct-Jan
C. connata	CS	Sep-Nov	E	Oct-Dec
C. gouriana	CS	Nov-Feb	E	Mar-May
C. grewiiflora	CS	Nov-Feb	E	Mar-May
C. montana	CS	Jul-Aug	E	Sep-Nov
C. napaulensis	CS	Apr-May	E	Jun-Aug
C. smilacifolia	CS	Oct-Nov	E	Dec-Mar
Clitoria ternatea	CA	Jan-Feb	E	(Jul)
Cobaea scandens	CS	Jan-Feb	E	NR
Coccinia grandis	CA	Jun-Dec	E	Aug-Dec
Codonopsis affinis	CA	Aug-Sep	E	Sep-Dec
C. inflata	CA	Aug-Oct	E	Sep-Dec
C. javanica	CS	Aug-Oct	E	Sep-Dec
Combretum flagocarpum	CS	May-Aug	Am	Nov-Dec
C. roxburghii	L	Apr-Jun	Am	Sep-Oct
Croton caudatus	CS	Apr-May	A	Jun-Oct
Cryptolepis buchanani	CS	May-Jun	E	Sep-Feb
C. sinensis	CS	May-Jul.	E	Oct-Feb
Cucurbita maxima	CA	NR	NR	May-Aug
Cuscuta relexa	CA	SEp-Dec	Am	Dec-Apr
Cuscuta sinensis	CA	(Sep)	Am	Dec-Apr
Cyclanthera pedata	CA	Jun-Aug	E	(Sep)
Cyclea barbata	CS	Aug-Oct	A	Nov-Feb
C. bicristata	CS	Mar-May	A	Apr-may
Cynanchum corymbosum	CS	Sep-Oct	E	Nov-Jan
Dalbergia pinnata	CS	Mar-Jul	E	Oct-Dec
D. rimosa	CS	(May)	E	(Oct)

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D. stipulacea	CS	Apr-Aug	E	Oct-Apr
D. volubilis	CS	Jan-Mar	E	Apr-Jun
Deeringia amaranthoides	CA	Nov-Dec	A	Nov-Jan
Dicentra paucinervia	CA	Aug-Sep	E	Sep-Nov
D. scandens	CA	Aug-Sep	E	Sep-Oct
Dioscorea alata	CG	Aug-Sep	A	NR
D. belophylla	CG	Aug-Sep	A	Dec-Mar
D. bulbifera	CG	Jul-Oct	A	Oct-Feb
D. glabra	CG	Aug-Nov	A	Oct-Dec
D. hispida	CG	Aug-Oct	A	Sep-Feb
D. kamoonensis	CG	Aug-Sep	A	(Oct)
D. pentaphylla	CG	Jul-Sep	A	Nov-Dec
D. prazeri	CG	Jul-Sep	A	Aug-Feb
Diplocyclos palmatus	CA	Aug-Oct	E	Sep-Jan
Dumasia villosa	CA	Sep-Oct	E	Sep-Nov
Dysolobium grande	CS	Feb-May	E	May-Jun
Edgaria darjeelingensis	CA	Jun-Nov	E	Sep-Dec
Elaeagnus conferta	CS	Nov-Dec	E	Mar-May
E. pyreformis	CS	Sep-Dec	E	Jan-Apr
Embelia ribes	CS	(May)	E	NR
Entada rheedii	L	Feb-Jun	E	Oct-Dec
Erycibe paniculata	CS	Oct-Dec	E	Jan-Mar
Euonymus echinatus	CS	Apr-Jun	A	Aug-Oct
E. vagans	CS	Apr-Jun	A	Sep-Dec
Fallopia convolvulus	CS	Jul-Nov	E	NR
Galium asperifolium	CA	Jul-Sep	E	Oct-Dec
G. elegans	CA	Jun-Sep	E	Jul-Dec
G. hirtifolium	CA	Sep-Dec	E	NR
Gentiana speciosa	CA	Aug-Nov	E	Nov-Jan
Gomphogyne cissiformis	CA	Sep-Oct	E	Oct-Dec
Gouania leptostachya	CS	Jun-Jul	E	Sep-Nov
Gymnema sylvestre	CS	Mar-Apr	E	NR
G. thomsonii	CS	Jun-Aug	E	NR
Gymnopetalum cochinchinense	CA	Jul-Sep	E	Sep-Nov
Gynostemma pentaphyllum	CS	Jul-Oct	E	Sep-Nov
Hedera nepalensis	CS	Aug-Sep	A	Jan-May
Herpetospermum pedunculosum	CA	Aug-Sep	E	Oct-Nov
Heterosmilax japonica	CS	Apr-Jun	E	(May)

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Hedyotis scandens	CS	Sep-Nov	E	Oct-May
Holboellia latifolia* var. *latifolia	CS	May-Jul	E	Oct-Nov
var. *angustifolia*	CS	Mar-May	E	NR
Hiptage bengalensis	CS	Feb-Apr	E	May-Jul
Hodgsonia macrocarpa	CA	Mar-may	E	Jul-Aug
Holmskioldea sanguinea	CS	Oct-Jan	A	Feb-Apr
Hydrangea anomala	CS	Apr-May	Am	Aug-Oct
Ichnocarpus frutescens	CS	Oct-Nov	E	Jan-Feb
Ipomoea angulata	CS	Oct-Feb	E	Feb-Apr
I. muricata	CS	NR	NR	Oct-Feb
I. pestigridis	CS	NR	NR	Oct-Feb
I. purpurea	CS	May-Dec	E	Dec-Apr
I. quamoclit	CS	Jun-Sep	E	Aug-Nov
Jasminum dispermum	CS	Dec-May	E	NR
Kadsura heteroclita	CS	May-Jul	E	Aug-Sep
Lathyrus apahca	CA	Feb-Apr	E	NR
Leycesteria formosa	CS	May-Jun	E	Sep-Nov
L. gracilis	CS	Oct-Dec	E	Feb-Jun
Lonicera acuminata	CS	Jun-Jul	E	Sep-Dec
L. glabrata	CS	Aug-Oct	E	Oct-Nov
L. japonica	CS	May-Dec	E	NR
L. macrantha	CS	May-Jun	E	Jul-Oct
Luffa acutangula	CA	Sep-Oct	E	Nov-Dec
L. aegyptica	CA	Oct-Nov	E	(Oct)
Melothria angulata	CA	(Apr)	E	Oct-Nov
M. heterophylla	CA	Jun-Sep	E	Sep-Dec
M. mucronata	CA	Sep-Oct	E	Oct-Nov
Merremia hirta	CS	Feb-Jun	E	NR
M. umbellata	CS	Feb-Apr	E	May-Jun
M. vitifolia	CS	(Mar.)	E	NR
Microchites ellipticus	CS	Apr-Sep	E	Sep-Dec
Mikania micrantha	CS	Sep-Nov	Am	Oct-Nov
Milletia cineria	CS	May-Jun	E	Sep-Jan
M. extensa	CS	Apr-Jun	E	Nov-Feb
M. pulchra	L	May-Jun	E	NR
Mimosa himalayana	CS	Sep- Oct	Am	Nov-Dec
Momordica charantia	CA	Apr-May	E	(Aug)
M. cochinchinensis	CA	Aug-Oct	E	(Nov)

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M. dioica	CA	Aug-Oct	E	(Nov)
Mukia maderaspatana	CA	Jun-Oct	E	Sep-Dec
Mucuna macrocarpa	L	Apr-Jul	E	Aug-Sep
M. nigricans	L	Jun-Aug	E	Dec-Apr
M. prurita	CS	Aug-Sep	E	Nov-Jan
Myriopteron paniculatum	CS	(Aug)	E	NR
Naravelia zeylanica	CS	Jun-Jul	E	Oct-Feb
Natsiatum herpeticum	CS	Nov-Jan	Am	(Feb)
Paederia foetida	CS	Aug-Sep	E	(Jan)
P. scandens	CS	Sep-Oct	E	Dec-Feb
Prabaena sagittata	CS	May-Jun	A	Sep-Dec
Paramigyna monophylla	CS	Apr-Jun	E	May-Aug
Parthenocissus semicordata	CS	May-Jul	E	Sep-Dec
Passiflora edulis	CS	Mar-Aug	E	Aug-Oct
P. foetida	CS	Jun-Aug	E	Aug-Oct
P. geminiflora	CS	Aug-Sep	E	Oct-Nov
Pergularia pallida	CS	May-Jun	E	(Oct)
Pericampylus glaucus	CS	Feb-May	A	Jun-Sep
Periploca calophylla	CS	May-Jun	E	NR
Persicaria chinensis	CA	Jun-Oct	Am	Jul-Dec
P. perfoliata	CA	Jul-Oct	Am	Oct-Jan
P. strigosa	CA	Jul-Sep	Am	(Aug)
P. thunbergii	CA	Jul-Oct	Am	Sep-Dec
Piper attenuatum	CS	Aug-Dec	A	Dec-Mar
P. chaba	CS	Apr-May	A	Aug-Sep
P. longum	CS	May-Aug	A	Nov-Feb
P. mullesua	CS	Aug-Sep	A	Aug-Dec
P. nigrum	CS	Jun-Jul	A	NR
P. pedicillatum	CS	May-Sep	A	Sep-Feb
P. peepuloides	CS	Oct-Dec	A	Feb-Mar
P. suipiqua	CS	May-Aug	A	Aug-Jan
P. sylvaticum	CS	Mar-May	A	May-Jun
Plectocomia himalayana	CS	Jul-Sep	A	Apr-May
Porana grandiflora	CS	Aug-Sep	E	Oct-Jan
Pothos cathcartii	CS	Nov-Apr	E	NR
P. scandens	CS	May-Jun	E	NR
Pueraria phaseoloides	CS	Sep-Oct	E	(Nov)
var. *subspicata*	CS	(Nov)	E	(Dec)

Contd....

P. sikkimensis	L	Feb-Mar	E	Apr-Jun
Rhaphidophora calophylla	CS	Jul-Aug	E	Dec-Jun
R. glauca	CS	Sep-May	E	NR
Rhynchodia wallichii	CS	Mar-Jun	E	Sep-Jan
Rosa banksiae	L	Apr-May	Am	NR
R. brunonii	CS	May-Jun	Am	NR
R. sericea	CS	Apr-May	Am	NR
Rubia chaerifolia	CA	Sep-Oct	E	Oct-Apr
R. manjith	CA	May-Aug	E	Sep-Mar
R. wallichiana	CA	Jul-Nov	E	Aug-Oct
Rubus acuminatus	CS	Jul-Sep	Am	Aug-Dec
R. ellipticus	CS	Apr-Mar	Am	NR
R. indotibetinus	CS	Apr-Jun	Am	Jul-Aug
R. lineatus	CS	Mar-Jun	Am	Jun-Sep
R. niveus	CS	May-Jul	Am	Jul-Sep
R. paniculatus	CS	Jun-Aug	Am	Aug-Dec
R. rugosus	CS	Jun-Aug	Am	Aug-Dec
R. senchalensis	CS	Jul-Aug	Am	Aug-Sep
R. wardii	CS	May-Jun	Am	Jul-Oct
Sabia campanulata	CS	Apr-Jun	E	May-Aug
S. leptandra	CS	Apr-Jun	E	NR
S. parviflora	CS	Mar-May	E	May-Aug
Schefflera roxburghii	CS	Apr-Jun	Am	NR
var. ***venulosa***	CS	Mar-Apr	Am	NR
var. ***macrophylla***	CS	May-Jun	Am	NR
Schisandra grandiflora	CS	Apr-Jun	E	Sep-Oct
S. neglecta	CS	Apr-Jul	E	Apr-Oct
S. propinqua	CS	Jun-Jul	E	Aug-Nov
Sechium edule	CG	Jun-Oct	E	Sep-Nov
Senecio araneosus	CS	Oct-Dec	Am	Dec-Jan
S. wightianus	CS	Oct-Dec	Am	Dec-Mar
Schuteria involucrata	CS	Sep-Dec	E	Nov-Jan
Smilax aspericaulis	CS	Sep-Nov	E	NR
S. ferox	CS	Apr-May	E	May-Dec
S. glaucophylla	CS	Mar-Apr	E	NR
S. lanceifolia	CS	May-Jun	E	May-Dec
S. ovalifolia	CS	Apr-Jun	E	Aug-Nov
Synotis sikkimensis	CS	(Oct)	Am	NR

Contd....

S. tetrantha	CS	Aug-Oct	Am	NR
Solanum jasminoides	CS	Apr-Oct	E	NR
Stephania elegans	CG	May-Aug	A	Oct-Dec
S. glabra	CG	Mar-Jun	A	May-Sep
S. glandulifera	CG	Feb-May	A	Jul-Oct
S. japonica	CG	Jun-Jul	A	Sep-Dec
Streptolirion volubile	CA	Aug-Oct	E	Oct-Dec
Tetrastigma bracteolatum	C	Aug-Oct	E	Dec-Feb
T. dubium	CS	Mar-Apr	E	Apr-Jun
T. leucostaphyllum	CS	Mar-May	E	Apr-Nov
T. obtectum	CS	Apr-May	E	Aug-Oct
T. rumicispermum	CS	Apr-Jun	E	Sep-Nov
T. thomsonianum	CS	NR	NR	(Nov)
Thladiantha cordifolia	CS	May-Aug	E	Jun-Oct
Thunbergia coccinea	CS	Jul-Sep	E	Oct-Mar
T. fragrans	CS	Jul-Nov	E	Oct-Feb
T. grandiflora	CS	Aug-Dec	E	Jan-Dec
T. lutea	CS	Aug-Sep	E	Sep-Dec
Toddalia asiatica	CS	Feb-May	E	Aug-Dec
Treutlera insignis	CS	Aug-Sep	E	Oct-Nov
Trichosanthes bracteata	CS	Jul-Aug	E	NR
T. cordata	CS	Jun-Sep	E	Sep-Dec
T. dioica	CS	Apr-Jun	E	NR
T. lepiniana	CA	Jul- Aug	E	Aug -Nov
T. wallichiana	CS	Jul-Aug	E	Sep-Nov
Tripterospermum volubile	CA	Jun-Oct	E	Oct-Dec
Uvaria hamiltonii	L	May-Jul	Am	Aug-Sep
Ventilago denticulata	L	Sep-Dec	Am	May-Jun
Vicia hirsuta	CA	Jan-Mar	E	Feb-Apr
V. sativa	CA	Jan-Mar	E	Feb-Apr
V. tetrasperma	CA	Mar-May	E	Aug-Sep
Vigna vexillata	CA	Jul-Sep	E	Oct-Nov
Wisteria chinensis	L	Apr-May	E	NR
Zanthoxylum oxyphyllum	CS	Apr-May	E	May-Dec

7.2.1. RESULTS AND DISCUSSION

Altogether 252 species and varieties of Angiospermic Climbers of Darjeeling and Sikkim Himalayas have been included in the present calendar (Table 7.2) of a total collection of 284 species. The flowering period of remaining 26 species could not be recorded during the present investigation. These are also missing from such calendar published previously. Following list of these plants are:

Acacia torta, Aconogonum molle var. *frondosum , A. molle* var. *rude, Ampelocissus rugosus, Aristolochia platanifolia, Ceropegia longifolia* var. *darjeelingensis, Clematis wightiana, Clitoria ternatea, Cucurbita maxima, Derris cuneifolia, D. ferruginea, Dioscorea deltoidea, D. hamiltonii, D. pubera, D. tomentosa, D. trinervia, Embelia floribunda, Ficus hederacea, Hemidesmus indicus, Lonicera hispida, Tetrasera sarmentosa, Tiliacora acuminata, Tinospora cordifolia, Tylophora exilis, T. indica, Uncaria sessilifructus.*

A close scrutiny of the calendar shows that only two plants *Rubus ellipticus* and *Coccinia grandis* flowers round the year. Few other plants like *Ipomoea pupurea, Lonicera japonica, Persicaria chinensis, Rhaphidophora glauca, Solanum jasminoides*, etc. for 8-10 months. On the hand , there are some plants which flowers for very brief period not more than 2 months, like *Actinidia strigosa, Aristolochia cathcartii, A. tagala, Bauhinia scandens, Clematis montana, C. napaulensis, C. smilacifolia, Cyclanthera pedata, Deeringia amaranthoides, Elaeagnus conferta, Hydrangea anomala, Lonicera acuminata L. macrantha, Pergularia pallida, Sabia parviflora, Schisandra propinqua, Smilax glaucophylla, Trichosanthes wallichiana, Wisteria chinensis, Zanthoxylum oxyphyllum*, etc.

In cases of plants of wide altitudinal distribution and adaptability, while the calendar is showing a long flowering period, the actual duration of flowering at a particular locality may be quite short. *Ampelocissus sikkimensis, Ceropegia pubescens , Dioscorea bulbifera, Edgaria darjeeligensis, Gentiana speciosa, Persicaria chinensis, Pothos cathcartii, Thladiantha cordifolia*, etc are some such plants.

The highest number of 100 species of plants produce flowers (Table-7.3) in the month of August and September. An earlier peak, slightly smaller has been recorded during the months of May and June (99 and 94 species respectively). A steady decrease in flowering initiates from the month of October (75 spp) continue upto the month of January (14 spp). Similar two peaks in flowering of angiospermic plants in Darjeeling have been recorded by Das (1987). Bhujel (1996) have also been recorded June- supplements as the Dicotyledonous plants in Darjeeling.

This generalised behaviour of the vegetation may be explained if correlated with the climatic conditions of the region. November to February are the winter months in Darjeeling and Sikkim when majority of the annuals die and a very large number of plants opt for a sleeping or dormancy period, loosing their leaves and suspending all types of growth-activities. Rainfall also remain very low during these months. On the other hand, specially in high altitude places snow covers the low-lying vegetation. 14 and 22 species of climbers have been recorded to flower in January and February, respectively, but most of these plants are from the low altitude areas where winter temperature is like the summer temperature of temperate regions of these hills. However, plants like *Cobaea scandens, Sabia parviflora, Clematis grewiiflora* and *Rubus ellipticus* grow in high altitude places- so those are specially adopted to maintain such a life-style in much chilly environment.

A few more plants start showing signs of growth from the last quarter of February, i.e. with the start of increase of day temperature. Rainfall also start increasing from March. Now, many plants start breaking dormancy with the initiation of flowering. This trend continues upto June-the period, when the rainfall is not too heavy. So, many plants continue to flower upto June in the " highest temperature but less moist" season.

Monsoon arrives during the middle June. Most of the plants now become extremely bushy in their vegetative growth. This rain-initiated excitation decrease their reproductive activity and that is why there is a drop in flowering during July. But many plants again start flowering from the later part of August which continues till the start of the fall of mercury level in the last part of September. Spring is quite cold in high altitude which gradually pass into the winter from the middle of November.

This type of rise and fall in the number of plants flowering is also observed in different pollination groups (Fig 7.3A). Das and Chanda (1987) has also observed the similar phenomena. However, the concentration of entomophilous climbers in this part of Eastern Himalaya is quite distinct, where out of 252 plants (with record of flowering) 182 species (i.e. 72.22 %) are entomophilous. In addition, another 35 species are amphiphilous i.e. they also take the help of insects for pollination. Moist climate, with dense fog and long duration rainfall hinders the pollination by air.

Like flowering period, the knowledge about fruiting period, specially the period of its ripening is very important, specially for the collection of seeds and for the study of fruits and seeds dispersal. As it can be realised, fruit ripening period is equally important with only few other stages in the life-history of plants e.g. germination and initiation of flowering. This is more important in annuals because that is the last stage in their compact life-cycle after which they die. Plants with a broad flowering

Table 7.3 : Numerical expression of the flowering calendar of the angiospermic climbers of Darjeeling and Sikkim Himalayas (upto 3200m).

	Monthwise distribution of flowering climbers												
	Total Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Anemophilous	no.35	1	2	5	9	15	11	11	18	16	7	5	4
	%13.9	2.86	5.71	14.3	25.71	42.85	13.42	31.42	51.42	45.71	20.0	14.3	11.42
Entomophilous	no.182	11	19	33	54	70	69	60	71	71	54	28	18
	%72.22	6.04	10.43	18.13	29.7	38.46	38.0	33.0	39.0	39.0	29.7	15.4	9.9
Amphiphilous	no.35	2	1	3	9	14	14	12	11	13	14	8	6
	%13.9	5.71	2.86	8.6	25.71	40.0	40.0	34.3	31.42	37.14	40.0	22.85	17.14
Total	252	14	22	41	72	99	94	83	100	100	75	41	28
	%	5.55	8.73	16.3	28.6	39.3	37.3	32.92	39.7	39.7	29.8	16.3	11.11

Fig. 7.2A Flowering & fruiting calendar of the angiospermic climbers of Darjeeling & Sikkim Himalayas

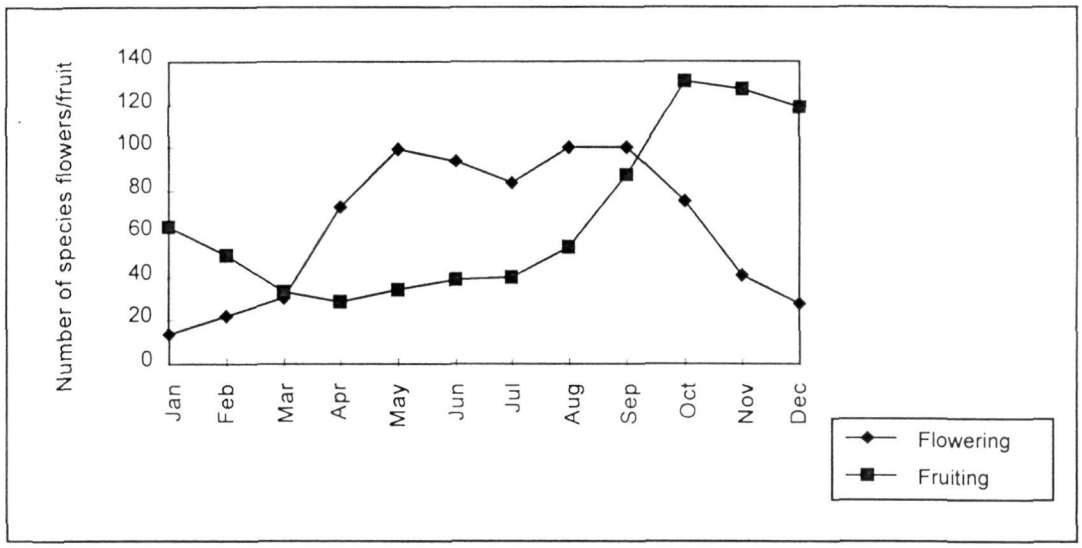
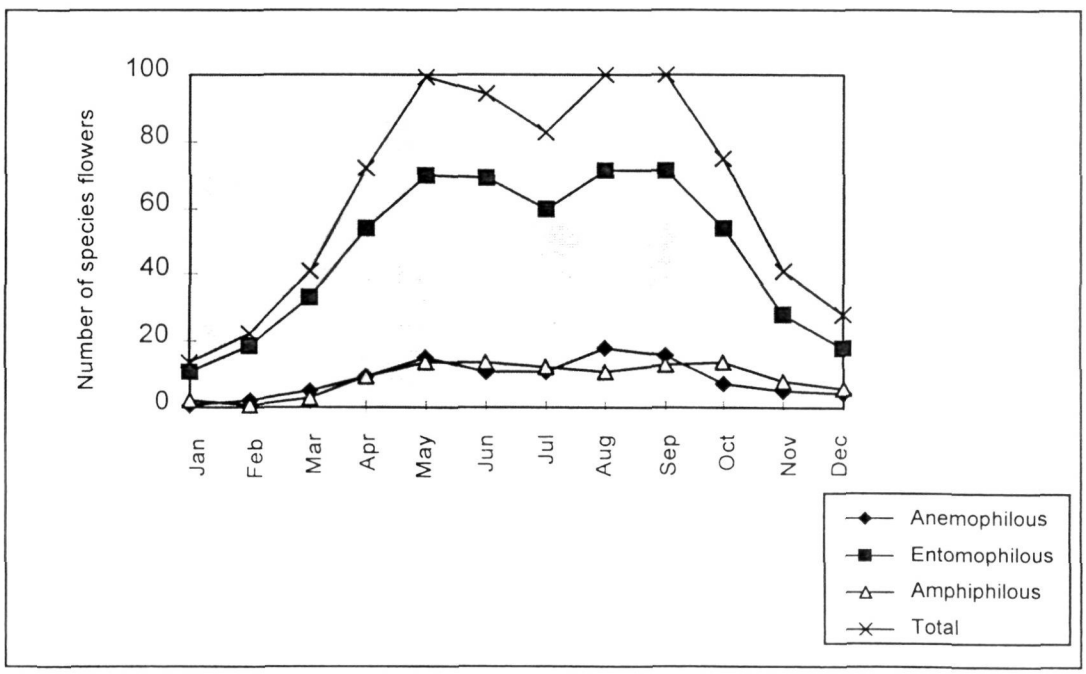


Fig. 7.3A Flowering calendar of the angiospermic climbers of Darjeeling & Sikkim Himalayas



period also produce fruits, as expected, over a broad period. Fruit bearing period is almost simultaneous with the flowering period. All flowers in a plant do not bloom on the same day, so, a flower blooming one week after the initiation of blooming is certainly accompanying the young fruits developed from the flowers bloom on the first day. If an entire fruiting period is presented in a calendar than a part of it will also cover entire or a good part of the flowering period in most of the species.

Of the entire fruiting period two stages are important (i) stage of harvesting and (ii) the stage of fruit ripening ending with dispersal.

Out of 252 species presented in the combined (i.e. flowering plus fruiting) calendar (fig.7.2A), the fruiting period of only 24 species could not be recorded or collected.

The analysis of the fruiting period of 220 species reveled that, the most of the species selected the pre-winter period for their fruit ripening. Fig.7.2A shows a sharp and fall peak which revealed its summit in October. Least number of species ripen their fruits during April. While the descending of the graph initiate during November-December, it starts ascending during July-August. From August it rise very steadily and in October it attains the summit. In flowering period two peaks of almost equal height has been recorded during May and August-September. A comparison of the two climbers clearly indicate that most of these plants prefer to complete essential phases of their life cycle before braving the adventise of the winter. However plants growing low altitude areas face the winter in a different way. Quite a few winter annuals grow and flower during this season and ripen their fruits just after the chilling days of winter or over.

Like the width of flowering period of a species the fruit ripening period is also nearly equally wide. But, the plants with very wide flowering period do not produce fruits in equal proportion (flower/fruit-set ratio) in all parts of its range of flowering. Though flowering throughout the year or over a broad period, the amount of flower production is not equal all the time.

So, these plants like to complete their flowering and fruiting in a tolerable environmental condition when the supply of enough food for the purpose is possible.