CHAPTER – 5

Once I see the new green leaves, my heart may take to them too-
If I think of them as mementos of blossoms that scattered

PHENOLOGY

5.1. INTRODUCTION

All the species of *Acer* of the Darjiling-Sikkim Himalayas, except *A.oblongum* are deciduous. The phenology which is intimately related to the prevailing climatic condition of a place, chiefly the water relations, temperature cycle and photoperiods help better understanding of the reaction of different species to the phases of climatic cycle of a place.

Extensive works on the phenology of different species and vegetation have been carried out in different parts of the world (Harper 1906; Janzen 1967; Lieth 1970, 1974; Lieth and Radford 1971; Daubenmire 1972; Frankie *et al.* 1974; Putz 1979). In India, although the scope and need of this type of work is extremely high, only very little work has been done in some isolated patches. The phenology of some woody plants, chiefly trees, have been made in Garwal by Sundriyal (1990), Semalty and Sharma (1996); in North-East India by Booj and Ramakrishnan (1981), Sukla and Ramakrishnan (1982); in Srinagar by Kaul and Raina (1980); and in Kumaun by Ralhan *et al.* (1985). Studies in South India, chiefly the flowering phenology, have been made by Shivraj and Krishnamurthy (1989).

Although the flora of the Eastern Himalaya is extremely rich and diverse with numerous economically plants (Das and Chanda 1992, Das 1995) scanty work has been done in this field except for a flowering calendar of 1052 species of temperate angiosperms (Das and Chanda 1987). The present study was carried out on twenty randomly chosen plants belonging to different species of *Acer* form the Darjiling –Sikkim Himalayas, taking two sites representing the lower and upper limit of growth for each species and taking into account four phenophases i.e., leaf and or inflorescence sprouting; flowering and anthesis; fruit setting, development and retention and leaf and fruit drop, during two successive years from February 1997- February 1999. The characteristics of each species has been alphabetically given below followed by the tabulation of the major characteristics (Table 5.1.), of all the species along with the diagrammatic representation of the different phenophases of individual species.

5.2. SYSTEMATIC DESCRIPTION OF THE PHENOLOGY OF THE DIFFERENT SPECIES OF *Acer* L. OF THE DARJILING –SIKKIM HIMALAYAS:

Acer acuminatum Wallich ex. D. Don

Area of study: Kathak (Lachung, N.Sikkim) 3700m; Lachen (N.Sikkim)3900m.

LEAF EMERGENCE AND DEVELOPMENT :

The leaf initiation starts with the enlargement of the winter buds from the second week of April to the first week of May; the sprouting of the new leaves begin in the second to the third week of May arising a week later in the higher altitudes, and are yellowish green being pubescent and turn dark green by the end of May; the leaves towards the lower branches arise earlier with those in the crown showing a more or less synchronous emergence; The bud scales covering the leaves are shed by the 10^{th} to 14^{th} day of the emergence of the leaves after attaining a size of 2.3-2.6 x 0.6-0.75 cm; by the second week of June almost all leaves are mature.

FLOWERING :

The inflorescence appeared along with the leaf flush by the end of May to the first week of June; all the flowers were in full bloom by the second to third week of June; the total period of flowering was 14-19 days.

FRUITING:

The activity of fruit setting, maturation and retention was observed as a longer phenophase. The fruit setting started by the end of June maturing by late September; in 1997 57.14 % fruit setting occurred in the branches after 20 days whereas in 1998 it was 63.27% with the percentage retention after 50 days being 38.10% and 44.90 % respectively.

LEAF AND FRUIT FALL:

The leaves begin to turn yellow with a few turning red by the second week of October and by the second week of November leaf fall is initiated which extends to the third week of December; younger seedlings retain their leaves for a longer period; the trees remain leafless from the third week to December to the second week of May with the deciduous phase remaining for 144-152 days. Fruits are shed from mid-December to mid-January.

SEED GERMINATION : Under natural conditions seed germinations were not observed.

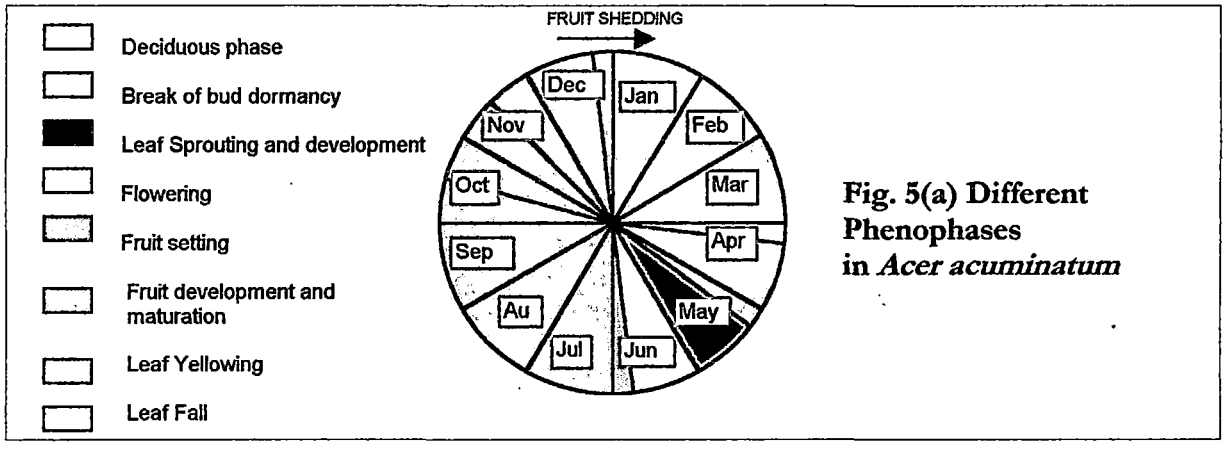

Fig. 5(a) Different Phenophases in *Acer acuminatum*

Acer campbellii Hook. f. & Thomson ex Hiern
Area of study Mirik (Darjiling) 1700m; Lachung (N.Sikkim) 3700m

LEAF EMERGENCE AND DEVELOPMENT: The leaf initiation starts with the enlargement of the leaf buds from the second week of March; the lower leaves towards the basal portion of the tree emerge 5-7 days earlier that those of the upper canopy which shows a more or less synchronous emergence arising in the second to the third week of April; the leaves are initially reddish being pendulous and by mid-May turn light green turning darker green by the end of May. The bud scales are shed by the 10^{th} –14^{th} day of emergence of the leaves attaining a size of 3.5-3.7 x 1.1-1.5 cm, although a few were found to main persistent and develop leaf like lobes at the apex; new crops of leaves also arise after the rains during the middle of September in the upper canopy.

FLOWERING:
The first inflorescence buds were observed by the end of April to the first week of May in the lower reaches being 7-10 days later in the higher reaches; about the third week most of the flowers were found to be in full bloom. The total period of flowering was 23-27 days.

FRUITING:
The activity of fruit setting, maturation and retention was observed as a longer phenophase. The fruit setting starts by the end of May, maturing by the end of September. In 1997 about 93.6 % fruit setting occurred in the branches after 20 days whereas in 1998 it was 95.59 with the percentage retention after 50 days being 83.52% and 82.84% respectively.

LEAF AND FRUIT FALL:
Leaf yellowing is initiated in the end of October and by mid week of November most of the leaves turn yellow with some turning brownish. Leaf fall begins from the second week of December and continues to the first week of January in the lower reaches being about 10-15 days earlier in the higher reaches; young saplings usually do not shed their upper leaves which usually remain densely crowded and curled during the winter and are shed just prior to the appearance of the new leaves; the deciduous phase of mature trees being 96-105 days; Fruits shed from end of December to mid-March with a few being retained upto the emergence of the next flush of leaves.

SEED GERMINATION: Germinating seedlings were observed in a number of places during field collection from the end of April to the middle of May.

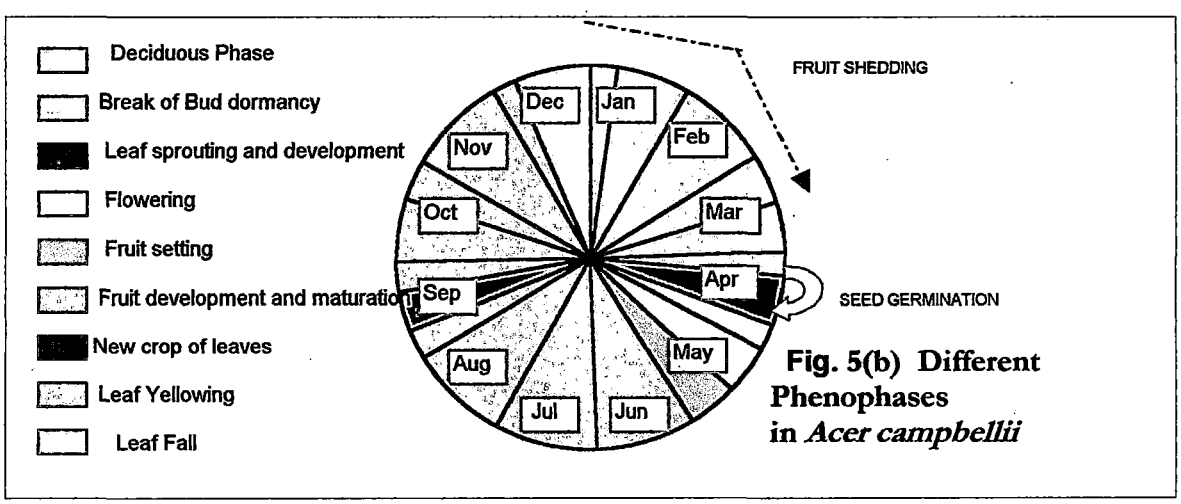

Fig. 5(b) Different Phenophases in *Acer campbellii*

Acer caudatum Wallich

Area of study Rechella (Kalimpong)2600m; Gamothang (W.Sikkim) 3600m

LEAF EMERGENCE AND DEVELOPMENT:

The leaf initiation starts with the enlargement of the winter leaf buds first the second week of March; the synchronous emergence of the leaves takes place from the end of April to the first week of May; the leaves are brownish green turning dark green by the end of May; bud scales are shed 10-14 days after emergence of the leaves attaining a size of 5.5-6.5 x 0.9-1.3 cm.

FLOWERING:

The inflorescence appear with the leaves between the end of April and the first week of May and by the second week of May all the flowers are in full bloom; the total period of flowering was 17-21 days.

FRUITING:

The fruit setting starts by the end of May. In 1997 about 79.03% fruit setting occurred in the branches after 20 days after flowering, whereas in 1998 it was 80.56 with the percentage retention after 50 days being 53.23 % and 48.61% respectively.

LEAF AND FRUIT FALL:

By the second week of October the colour of the leaves turn yellowish and this continues to the second week of November after which the leaves begins to fall upto the first week of December; the deciduous phase being 134-141 days long. The fruits are shed from the end of December to mid-February and none retained when the new leaves emerge.

SEED GERMINATION:

Germinating seedlings were observed in a number of places during field collection during end of May upto early June.

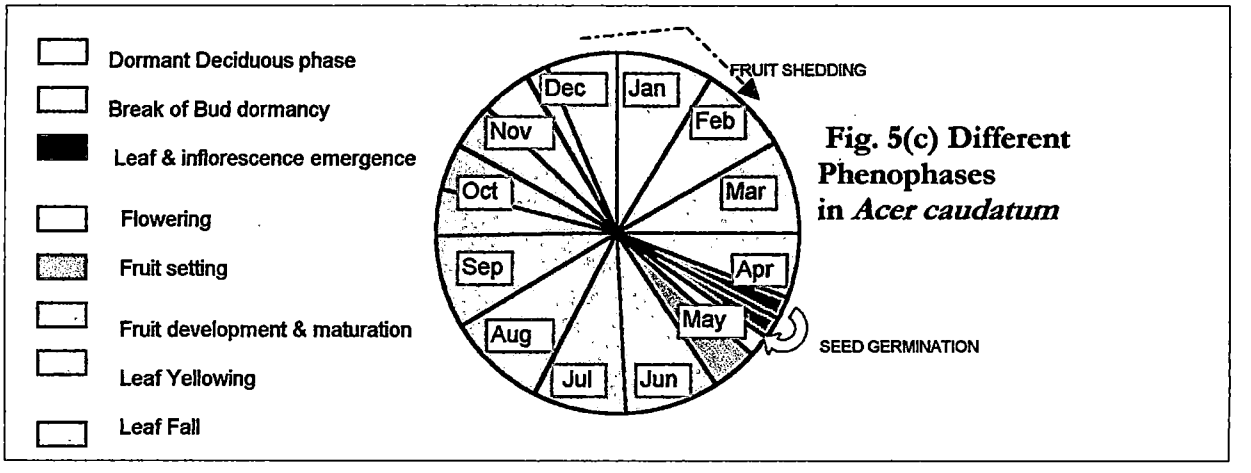

Fig. 5(c) Different Phenophases in *Acer caudatum*

Acer hookeri Miquel

Area of study: Sonada (Darjiling) 2000m; Tonglu(Darjiling) 3000m.

LEAF EMERGENCE AND DEVELOPMENT :

The leaf initiation starts with the enlargement of the winter buds in the mid-February. The more or less synchronous emergence of the leaves takes place from the last week of March to the second week of April being about 10-14 days later in the higher reaches; the leaves which are yellowish green to reddish, turn dark green by the end of April; the bud scales fall off within 9-14 days of the emergence of the inflorescence and leaves after attaining a size of 4.5-5 x 0.9-1cm. In some cases bud scales remain persistent and develop leaf like lobes at the apex.

FLOWERING:

The inflorescence arise with the fresh flush of leaves in the end of March to second week of April with almost all the flowers in full bloom by the end or April. The total period of flowering was 15-19 days.

FRUITING:

The fruits appear by the end of April to the first week of May and mature by late September to early October. In 1997 about 81.28.6 % fruit setting occurred in the branches after 20 days whereas in 1998 it was 87.39% with the percentage retention after 50 days being 72.15% and 73.42% respectively.

LEAF AND FRUIT FALL:

By the end of October the colour of the leaves turn yellow or red until third week of November, when the leaf fall begins. The trees become leafless by the third week of December in the higher reaches to the first week of January in the lower reaches. The deciduous phase being 92-111 days. The fruits are shed from the end of December and is maximum during February when it turns windy, however a few may be retained even upto the emergence of new crop of leaves.

SEED GERMINATION: Germinating seedlings were observed in a number of places during field collection during end of April to mid-May

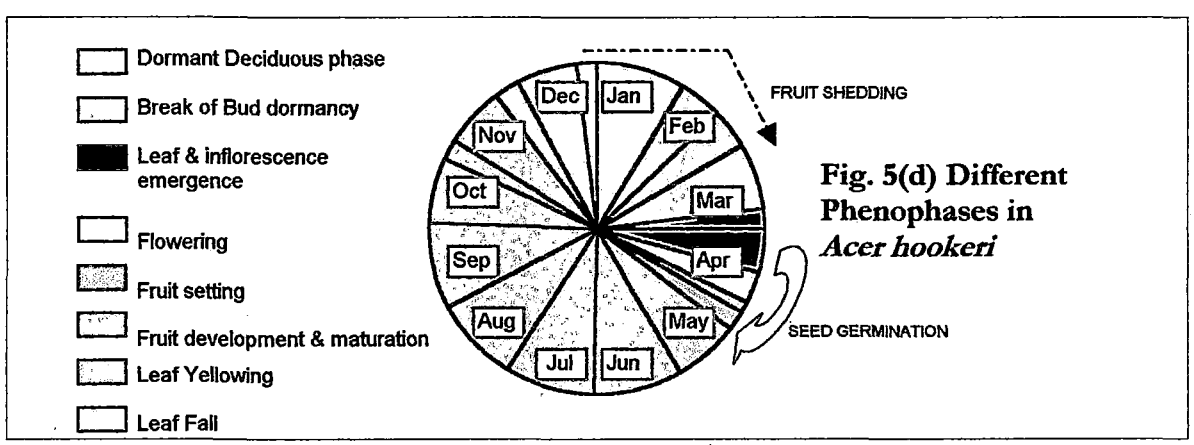

Fig. 5(d) Different Phenophases in *Acer hookeri*

Acer laevigatum Wallich

Area of study: Rungli-Rungloit (Darjiling)1500m; Jalapahar(Darjiling) 2400m

LEAF EMERGENCE AND DEVELOPMENT:

The leaf initiation starts with the growth of the winter buds from the end of February to the first week of March; The lower leaves emerge earlier than the upper leaves from the second week of April to the end of April; the leaves are light green to reddish in which turn dark green and leathery by the end of May; the bud scales fall within 10-14 days of the emergence of the leaves on attaining a size of 2.3-2.6 x 0.6-0.8 cm.

FLOWERING:

The inflorescence arise with the fresh flush of leaves from the second week to the end of April and the flowers in full bloom by the mid May. The total period of flowering was 21-25 days.

FRUITING: The activity of fruit setting initiates within 10-15 days of blooming. The fruits are initially greenish turning reddish by mid June attaining maturity by the end of August to mid September when they turn brownish by mid September. In 1997 about 80.56 % fruit setting of which 20 days whereas in 1998 it was 82.88 respectively % with the percentage retention after 50 days being 66.67% and 71.17 % respectively.

LEAF AND FRUIT FALL:

By the third week of November the leaves begin to turn brownish to red and the leaf fall begins from the middle of December to mid-January. The trees at lower altitudes retain their leaves longer by 15 –17 days, and some of them only partially shed their leaves(semi-deciduous). Moreover young saplings do not shed all their leaves longer falling off 15-17 days later than those of mature trees ; the deciduous phases lasts for 87-103 days. Fruits are shed from the end of October to end of January with few retained even upto emergence of new leaves.

SEED GERMINATION:

Germinating seedlings were observed in a number of places during field collection during end of April to mid-May.

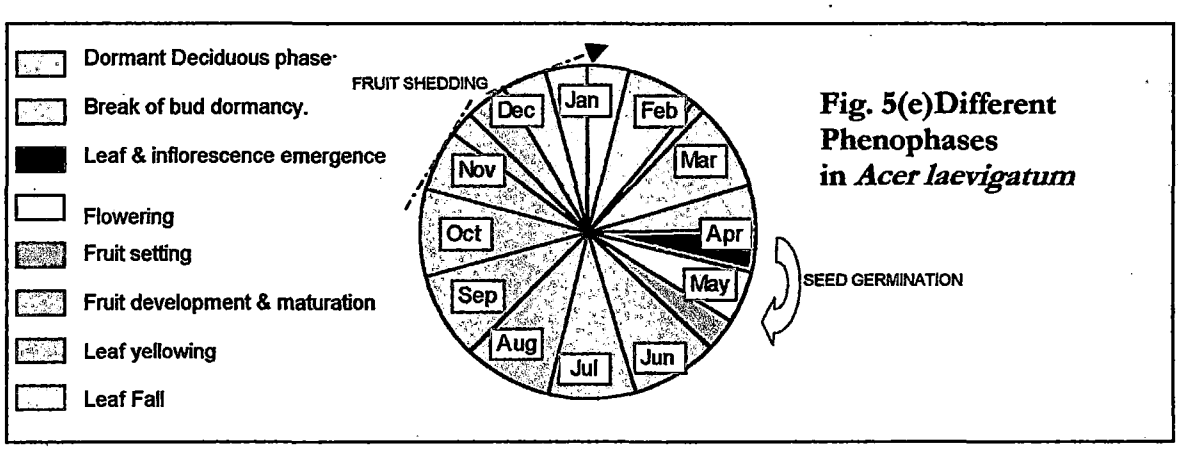

Fig. 5(e)Different Phenophases in *Acer laevigatum*

Acer oblongum Wallich ex DC.
Area of study: Pedong(Kalimpong),Botanical Garden(Darjiling)2000m .

LEAF EMERGENCE AND DEVELOPMENT:
Only a few leaves are shed during December to February with the species being evergreen. The dormant buds resume their activity by the second week of March. Branches with new leaves along with the inflorescence the third week of April to the first week of May. The young leaves are yellowish red turning dull green , being pubescent on both surfaces along with the inflorescence. By the end of May the leaves turn green and shiny on the upper surface with the lower surface being whitish and glabrous. New leaves appear after the rains during mid-August to mid-September and are pinkish to reddish.

FLOWERING:
The inflorescence arise with the fresh flush of leaves in the third week of April to the first week of May and by the end of second week of May most of the flowers are in full bloom. The total period of flowering is short, only between 10-14 days.

FRUITING:
The activity of fruit setting initiates within 4-7 days of blooming. In all observed specimen a parthenocarpic development of the fruits were observed to a high degree. The fruits are initially greenish being soft with the hardening of the pericarp by mid-June. The fruits become brownish by the third week of August. In 1997 about 76.96% fruit setting of which 75.57% were found to be parthenocarpic occurred in the branches after 20 days whereas in 1998 it was 82.18 with 63.82 % being parthenocarpic the percentage retention after 50 days being 68.59% and 75.25% respectively.

LEAF AND FRUIT FALL: Although this species is not deciduous, some of the mature leaves fall off during mid December and mid-February when the shedding of fruits of the previous year occur. The fruits are shed from mid-February to mid-April with some being retained even after the appearance of the new inflorescence.

SEED GERMINATION: Germinating seedlings were observed in a number of places during field collection during end of April to middle of May.

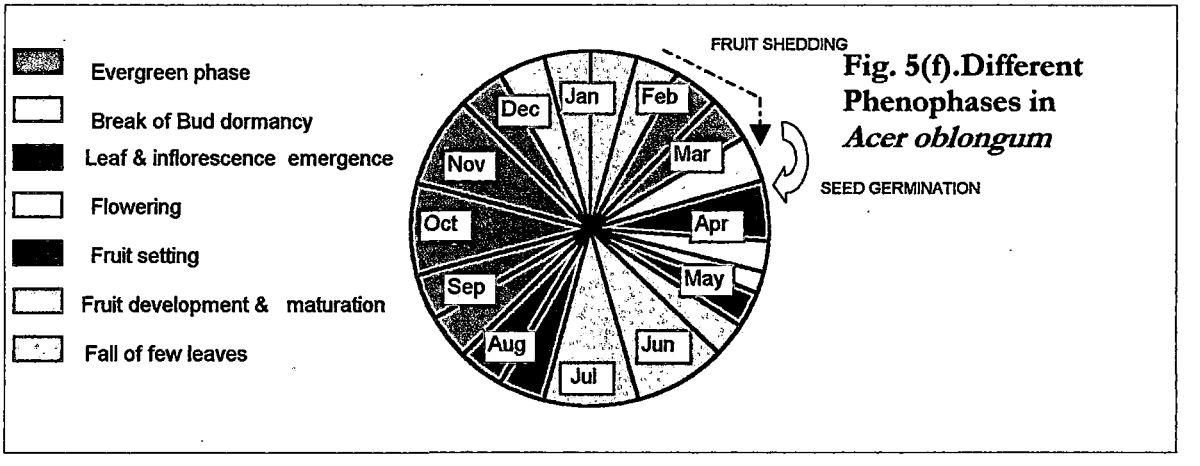

Fig. 5(f).Different Phenophases in *Acer oblongum*

Acer osmastonii Gamble

Area of study: Birch Hill (Darjiling)2000m.

LEAF EMERGENCE AND DEVELOPMENT:

The leaf initiation starts with the enlargement of the leaf buds from the second week of March. The lower leaves towards the basal portion of the tree emerge 7-10 days earlier than those of the upper canopy which shows a more or less synchronous emergence arising in the second to the third week of April; the leaves are initially light green and by mid-May turn dark green; the bud scales are shed after 10-14 days of the of the emergence of the leaves attaining a size of 4.2-4.5 x 1.2-1.3 cm; fresh crops of leaves also arise after the rains in mid September in the upper canopy.

FLOWERING:

The inflorescence appear in the first to second week of May and by the third week of May all the flowers are in full bloom. The inflorescences appear in the upper portion of the plant. The total period of flowering was 17-21 days.

FRUITING:

The activity of fruit setting, maturation and retention was observed as a longer phenophase. The fruit setting starts by the end of May. In 1997 about 86.41% fruit setting occurred in the branches after 20 days whereas in 1998 it was 83.65% with the percentage retention after 50 days being 76.70 % and 75.96 % respectively.

LEAF AND FRUIT FALL:

By the mid week of November the leaves turn yellow with some turning brownish; leaf fall begins from the third week of December and continues to the middle of January ; the deciduous phase being 94-109 days; The fruits are shed from December to February with a few being retained upto the emergence of the next flush of leaves.

SEED GERMINATION:

Germinating seedlings were observed in a number of places in the field collection during the end of April to the middle of May.

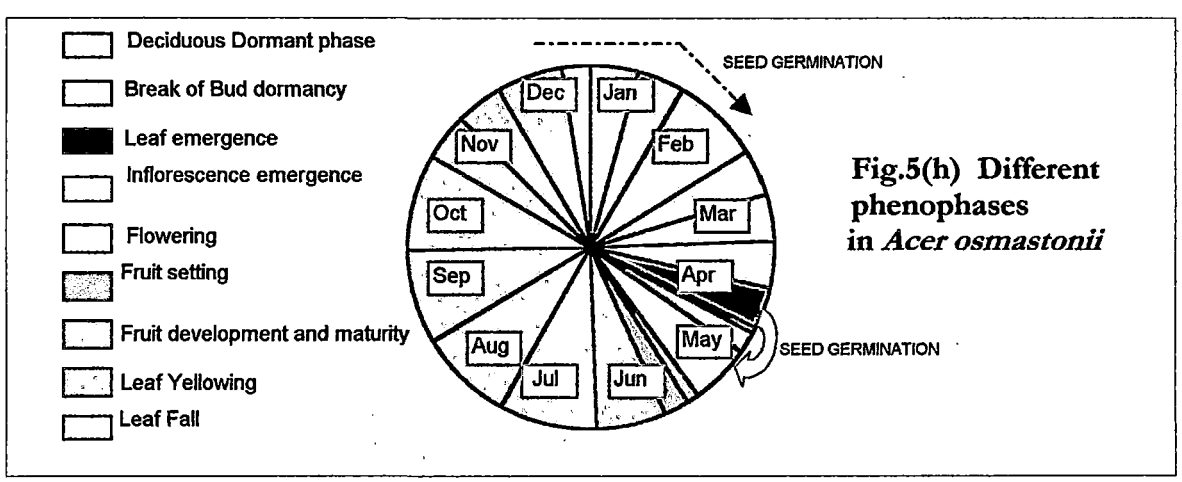

Fig.5(h) Different phenophases in *Acer osmastonii*

Acer palmatum Thunberg ex Murray
Area of study: Chowrasta (Darjiling) 2200m.

LEAF EMERGENCE AND DEVELOPMENT:
The leaf initiation starts with the enlargement of the leaf buds in the first to second week of February; the leaves along with the inflorescence appear by the second to third week of February and are red to yellowish green; by the end of February to first week of March the leaves are dark green. The bud scales fall within 5-7 days of the emergence of the leaves attaining a size of 0.8-1.1 x0.4-0.5 cm.

FLOWERING:
The inflorescence appear in the second to third week of February along with the new leaves and by the first week of March all the flowers are in full bloom. The total period of flowering was 10-14 days.

FRUITING:
The fruit setting starts by the third week of March. The fruits are initially green and begins to turn brown by mid-June. In 1997 about 82.93 % fruit setting occurred in the branches after 20 days whereas in 1998 it was 88.52% with the percentage retention after 50 days being 70.73% and 67.21% respectively.

LEAF AND FRUIT FALL:
By the second week of October the leaves begin to turn reddish and yellowish and eventually turns brown. Leaf fall begins by the second week of November to the first week of December ; the deciduous phase being 69 to 78 days; The fruits are shed from the end of November to end of December.

SEED GERMINATION: Germinating seedlings were observed in field during the end of April to mid May.

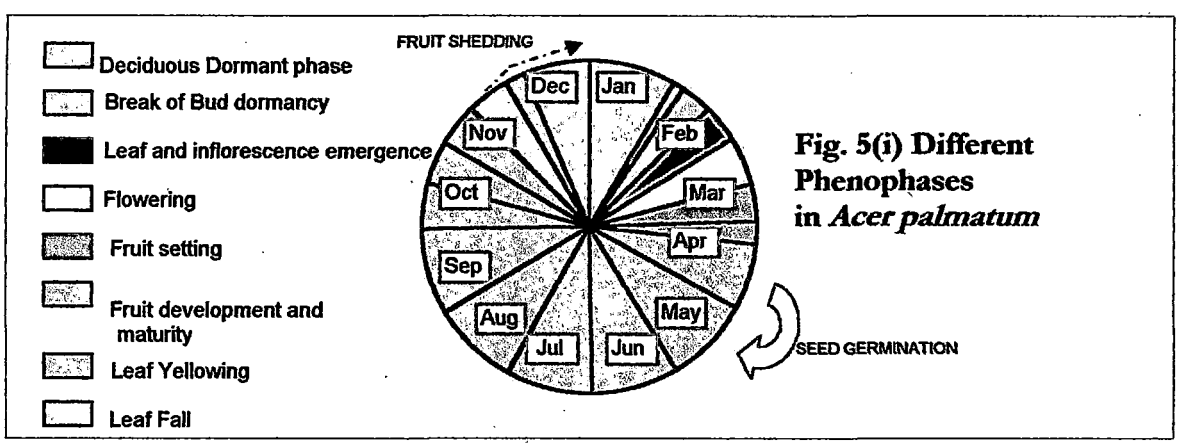

Fig. 5(i) Different Phenophases in *Acer palmatum*

Acer pectinatum Wallich ex Nicholson.
Area of study Megma (Darjiling)2500m, Sabargram (Darjiling)3600m.

LEAF EMERGENCE AND DEVELOPMENT:
The leaf emergence begins with the growth of the winter buds from the first week of March to mid March. The leaves along with the inflorescence appear in between the second and the third week of April; the leaves are yellowish green to red that turns dark green by the first week of May. The bud scales fall within 10-14 days of the emergence of the leaves attaining a size of 6-6.5 x 0.8-1.1 cm with some being persistent with the development of leaf like lobes at the apex.

FLOWERING:
The inflorescence arise with the fresh flush of leaves between the second and third week of April and by the end of first week of May most of the flowers are in full bloom. The total period of flowering was 19-24 days.

FRUITING:
The activity of fruit setting initiates within 7-10 days of blooming. In all observed specimen parthenocarpic development of the fruits were observed ; the fruits are initially green turning creamish pink maturing by the third week of August. In 1997 about 77.11 % fruit setting occurred after 20 days whereas in 1998 it was 81.94% with the percentage retention after 50 days being 69.88 % and 65.28% respectively.

LEAF AND FRUIT FALL:
The leaves turn yellow from the second week of October and leaf fall begins from the third week of November to the second week of December with the deciduous phase being 109-117days. The fruits are shed from the end of December to mid-February with a few being retained upto the emergence of new leaves.

SEED GERMINATION:
Germinating seedlings were observed in a number of places during field collection during end of May and early June.

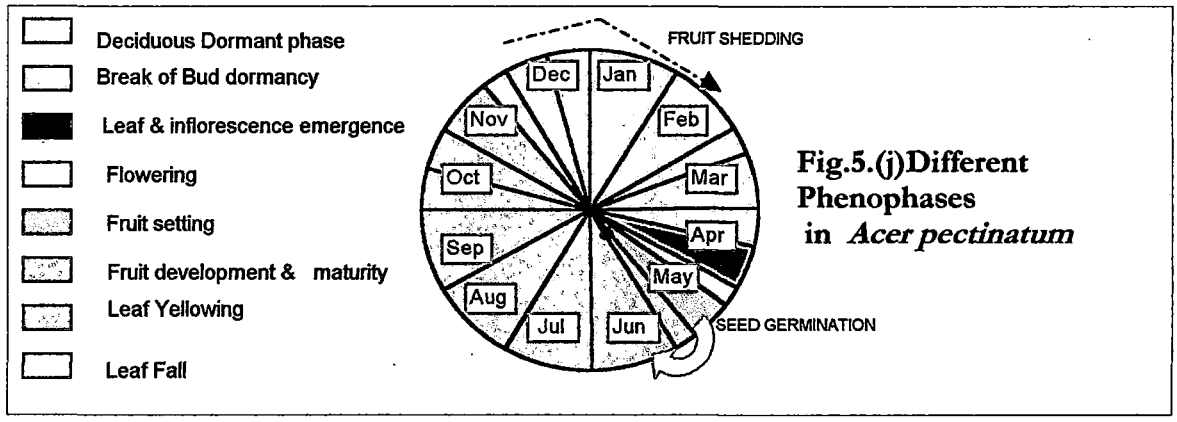

Fig.5.(j)Different Phenophases in *Acer pectinatum*

Acer sikkimense Miquel

Area of study Sonada (Darjiling)2000m; Tonglu (Darjiling)2800m .

LEAF EMERGENCE AND DEVELOPMENT :

The leaf initiation starts with the growth of the winter buds from the first week of February. The leaves along with the inflorescence appear from the end of February to the first week of March after the splitting of the bracts which have attained a size of 3.6-4.6x 1.35-1.5 cm. The leaves are light green to reddish similar to the colour those of the bracts that enclose them. The flowers are in full bloom by the third week of March. The lower inflorescence in which the carpels become abortive fall off by the end of March along with the deciduous bud scales that attain size of 5.5-6 x 1.1-1.4 cm. However a few of the bud scales remain persistent with the development of leaf like lobes at the apex. The bracts fall off 7-10 days after the emergence of the inflorescence and leaves. Not much differences were observed in the flowering and fruiting periods in the upper and lower reaches.

FLOWERING:

The inflorescence arise with the fresh flush of leaves in the first week of March and by the third week all the flowers are in full bloom. The total period of flowering was 10-14 days. Three of the eight stamens mature and dehisce earlier that the other.

FRUITING:

The activity of fruit setting initiates within 7 days of blooming. The fruits are initially greenish in colour and turns brownish by mid June. In 1997 about 94.23 % fruit setting occurred after 20 days whereas in 1998 it was 90.58 % with the percentage retention after 50 days being 87.63.32% and 89.23.54% respectively.

LEAF AND FRUIT FALL:

The leaves turn yellowish or reddish by the end of October and leaf fall begins by the third week of November, which often extends to first week of January, the deciduous phase lasting for 72-81 days. The fruits are shed from mid-December to mid-February with some being retained even at the time of appearance of the new inflorescence.

SEED GERMINATION: Germinating seedlings were observed in a number of places during the end of April to middle o May

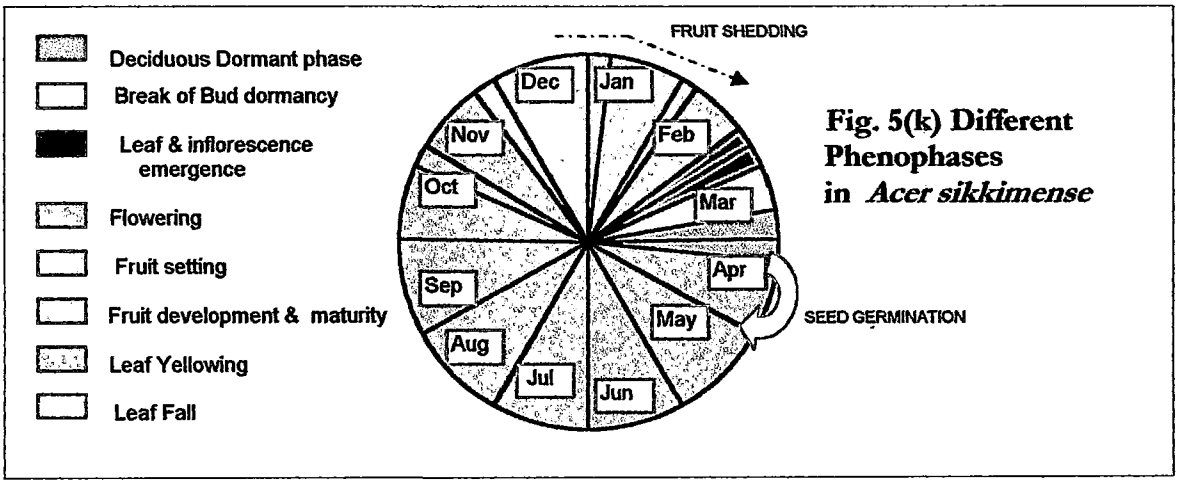

Fig. 5(k) Different Phenophases in *Acer sikkimense*

Acer stachyophyllum Hiern.
Area of study: Lachung(N.Sikkim)3800m.

LEAF EMERGENCE AND DEVELOPMENT:
The leaf initiation starts with the growth of the winter buds from the second week of April. The leaves along with the inflorescence appear from the second to third week of May. The young leaves are light green and turns dark green by the end of May. The bud scales fall within 7-10 days of the emergence of the leaves attaining size of 3.4-3.8 x 0.5-0.7 cm.

FLOWERING:
The inflorescence arises with the fresh flush of leaves in the second week of May and the flowers in full bloom by the end of May. The total period of flowering was 15-19 days.

FRUITING:
The activity of fruit setting initiates within 10-15 days of blooming. The fruits are initially greenish turning reddish by mid June with a large number of parthenocarpic fruits. The fruits turn brownish by mid September. In 1997 about 64.38 % occurred within 20 days whereas in 1998 it was 68.62% and the percentage retention after 50 days being 57.50 % and 59.26 % respectively.

LEAF AND FRUIT FALL:
By the second week of October the leaves begin yellowish to brown and leaf fall begins from the first week of November to the end of November; the deciduous phase being 128-142 days. Fruits are shed from mid November to end of January.

SEED GERMINATION: Not observed in natural conditions.

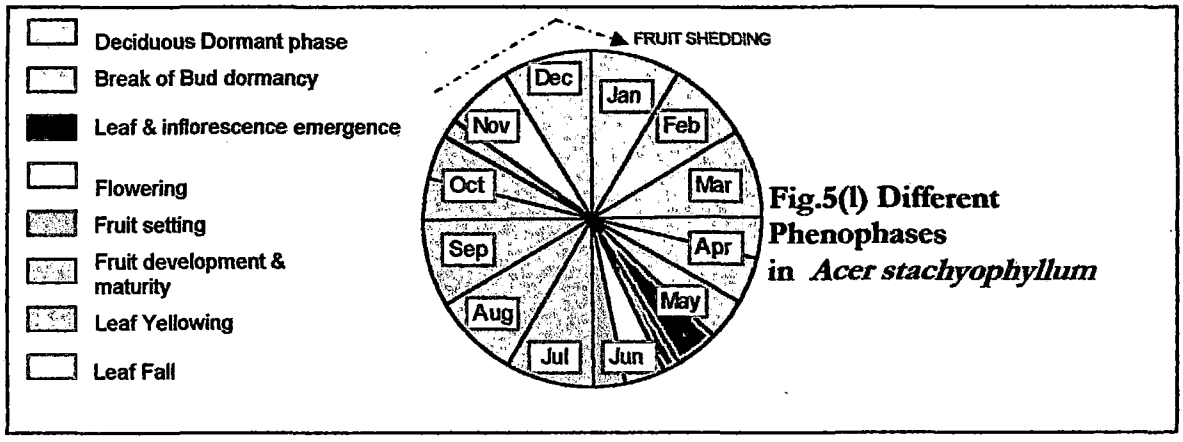

Fig.5(l) Different Phenophases in *Acer stachyophyllum*

Acer sterculiaceum Wallich
Area of study Gairibans (Darjiling)2400m.

LEAF EMERGENCE AND DEVELOPMENT: The leaf initiation starts with the growth of the winter buds from the second week of March. The leaves along with the inflorescence appear from the end of April to the first week of May. The young leaves are brownish green and turns green by the end of April. The bud scales fall within 10-14 days of the emergence of the leaves attaining a size of 3.7-4 x 0.9-1.3 cm. Large number of male flowers and inflorescence are shed within 10-14 days of emergence.

FLOWERING: The inflorescence arise with the fresh flush of leaves in the last week of April and by the third week of May all the flowers are in full bloom with the male flowers being shed along with a number of bisexual flowers from the first week of May. The total period of flowering was 17-21 days.

FRUITING: The activity of fruit setting initiates within 7-10 days of blooming. The fruits are initially greenish being soft and the pericarp hardening sets in by mid-June. The fruits turn brownish by mid September. In 1997 about 70.97 % fruit setting occurred within 20 days whereas in 1998 it was 78.57% with the percentage retention after 50 days being 56.45% and 59.52 % respectively.

LEAF AND FRUIT FALL: The leaves turn yellowish or reddish by the end of October and leaf fall begins by the third week of November which extends to first week of January, the deciduous phase lasts for 118-127 days; the fruits are shed from mid January to mid March with some being retained even at the time of appearance of the new inflorescence.

SEED GERMINATION: Germinating seedlings were observed in a number of places n during end of May and early June.

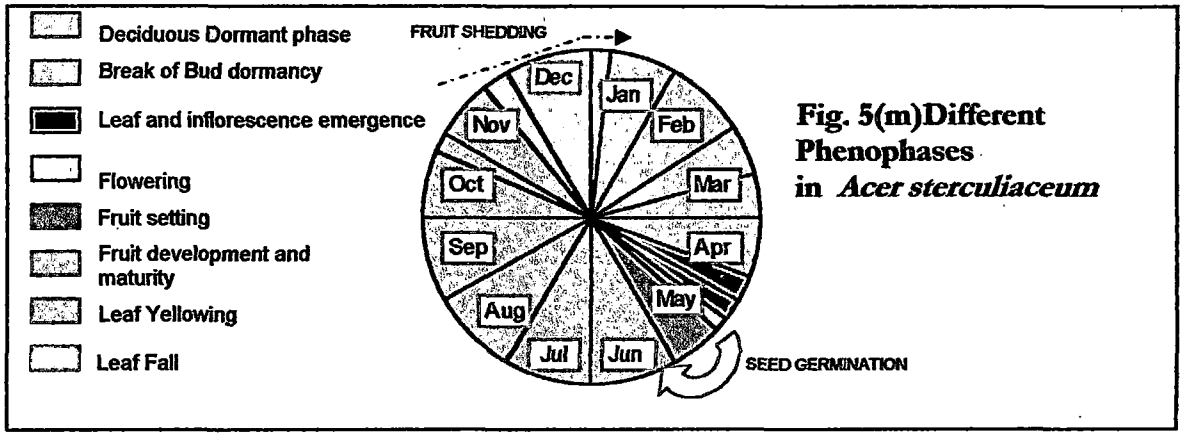

Fig. 5(m)Different Phenophases in *Acer sterculiaceum*

Acer thomsonii (Miquel) Murray

Area of study Manju (Darjiling)1100m; Chowrasta (Darjiling)2200m.

LEAF EMERGENCE AND DEVELOPMENT:

The leaf initiation starts with the enlargement of the bud from the second week of October arising 7-10 days later in the upper reaches. The leaves along with the inflorescence appear in from the first week of November. The young leaves are light green and turns green by the end of November. The bud scales fall within 10-14 days of the emergence of the leaves reaching a size of 3.4-3.7 x 1.3-1.5 cm.

FLOWERING:

The inflorescence arise with the fresh flush of leaves in the first week of November to the third week of November and the flowers are in full bloom by the end of November. The total flowering period was 17-19 days.

FRUITING:

The activity of fruit setting initiates within 7-9 days of blooming. The fruits are initially greenish and soft. The fruits turn brownish by mid March In 1997 about 80.36 % fruit setting occurred within 20 days whereas in 1998 it was 87.10% and the percentage retention after 50 days being 67.86 % and 75.81% respectively.

LEAF AND FRUIT FALL:

By the last week of August the leaves turn brownish and leaf fall begins from the first week of September that continued to the third week of September. The fruits are retained for a longer period and the previous years fruits can be observed at the time of the appearance of fresh flush of leaves and inflorescence with the deciduous period lasting for 45-56 days only. The fruits are usually shed during the end of June to the mid-September, although some of the previous years fruits may be retained until fruiting of the current year and shed in December-January.

SEED GERMINATION:

Under natural conditions seed germinations were observed during mid-December to the first week of January.

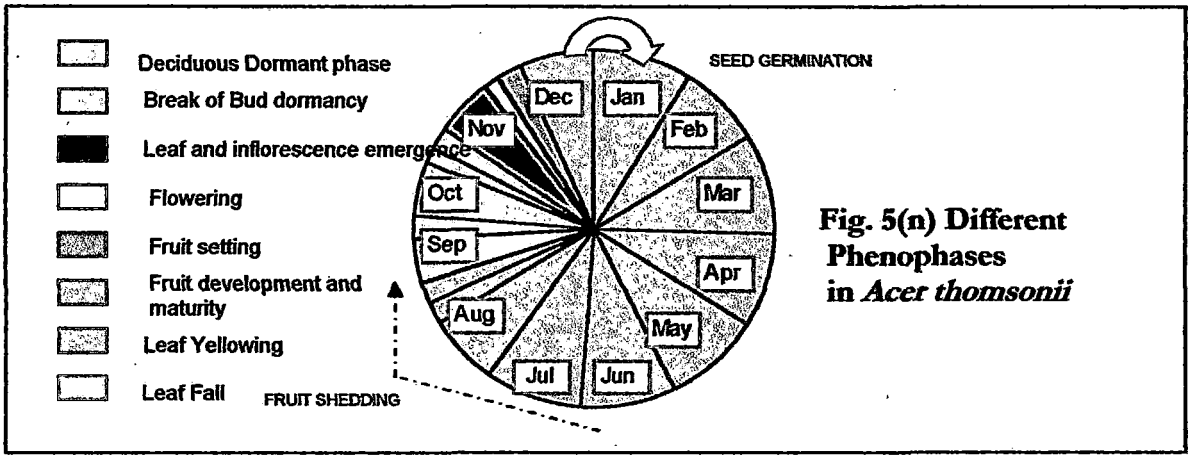

Fig. 5(n) Different Phenophases in *Acer thomsonii*

5.3. RESULTS AND DISCUSSION:

It was observed that the various specified events in the phenophases could be summarized under four broad headings for better understanding of the events.

5.3.1. LEAF EMERGENCE AND DEVELOPMENT

Except for *A.oblongum* all the other species of *Acer* of the region are deciduous. Barring *A.thomsoni* in all other species the sprouting of new leaves occur after a period of deciduous dormancy in the colder winter months. It was observed that the earliest break in dormancy along with the sprouting of the leaves occurred in early spring in case of *A.palmatum* and *A.sikkimense* during the 2nd and 3rd week of February and from the end of February to the 1st week of March respectively. In most of the other temperate and colder temperate species sprouting occurred between the end of March to middle of April in case of those occurring in the lower reaches and by the end of April to the 1st week of May in the higher reaches. The sprouting took place only in the 2nd to the 3rd week of May in the two sub-alpine species *A.acuminatum* and *A.stachyophyllum*. Moreover, it was observed that even in case of the same species leaf and inflorescence emergence in its lower altitudinal reaches took place 7-10 days earlier than in its higher altitudinal reaches. The species *A.thomsonii* which occurs in the lower altitudinal range in between the fringes of the upper tier of the sub-tropical and lower reaches of the sub-temperate zone is the only exception in which the sprouting of new leaves occurs during November after the monsoons.

Thus, it can be easily postulated that the emergence of the new leaves are related to the temperature with those in the higher altitudes where the temperature remains low emerging later than those in the lower altitudes where temperature becomes warmer with the onset of March and those in the higher range during the end of April to early May In Lachen located at 2697m maximum temperature in May is around 16.1 C and minimum at 4.8 a; at Kurseong at 1480m the maximum and minimum temperatures for March and April are 18.4°C and 21.9°C and 6.9°C and 10.6°C respectively

5.3.2. FLOWERING

Based upon the time of emergence of the inflorescence the different species of *Acer* occurring in the Darjiling-Sikkim Himalayas can be broadly placed under two major groups, *viz.* i) Species in which the inflorescence emerge along with the new leaves : This group includes most of the species of the region where 10 of the 13 species that includes *A.caudatum* , *A.hookeri*,

A.laevigatum., *A.oblongum* , *A.palmatum*, *A.pectinatum* , *A.sikkimense*, *A.stachyophyllum*, *A.sterculiaceum* , and *A.thomsonii* ; ii) Species in which the inflorescence appear after the initial flush of leaves that is exhibited by only three species *A. acuminatum* , *A.campbellii* and *A. osmastonii.* The duration of flowering is the shortest in case the sub-tropical species like *A.palmatum* and *A.oblongum*, which last for 10-14 days and similarly it is slightly longer for the two species found in the uppermost altitudes *A.acuminatum* and *A.stachyophyllum* where it extends from 14-19 and 15-19 days respectively. In most other species it is about three weeks or around 21 days. Like leaf emergence the emergence of the inflorescence is also dependent upon the temperature.

5.3.3. FRUIT SETTING, MATURITY AND RETENTION

This comprises the longest phenophase. The lengthy retention of the fruits allows it time to mature fully and also shed it at a time when dry strong winds blow in the region and allows better dispersal. It was observed that the lowest percentage of fruit setting occurred in case of the two species growing in the sub-alpine zone i.e. *A.acuminatum* and *A.stachyophyllum* where it was 57.14% and 63.27% ; 64.38% and 68.62% for 1997-1998 respectively with the highest in *A.campbellii* where it was 93.63% and 95.59% for the same two years. Moreover, the degree of fruit retention in the higher altitudes was comparatively much less than those in the lower altitudes. This may be due to the high velocity of the winds, snow and hail storms that occur in higher altitudes that prove to be detrimental to the retention of the fruits.

The fruits are usually dispersed during the winters when the velocity of the winds are high chiefly during January and February and snow and hailstorms also playing a part in the higher altitudes. The dispersal at this time remains conducive as a majority of the other deciduous trees in association shed their leaves and the fruits can be dispersed to greater distances unhindered by the canopy of the leaves of the species of *Acer* itself and also those of other plants.

5.3.4. GERMINATION OF SEEDS

That germination is related to both temperature and availability of moisture is well established by the different species of *Acer* in the region. In most growing in the temperate and lower fringes of the colder temperate zone the seeds germinate after a few spring showers in the end of April and early weeks of May, while in the higher reaches it usually occurred during the end of May to early June. In case of *A. thomsonii* germinating seed were observed during mid December to the first week of January during field studies. The seeds that germinate early i.e. by the first week of May in the temperate regions establish themselves prior to the forthcoming

monsoons survive whereas those that germinate a fortnight later are unable to survive as excessive water becomes detrimental to the survival of these seedlings that germinate later. In the lower reaches especially with respect to *A. thomsonii* it was observed that those seedlings that became established by the first week of January survived but those that germinated later could not establish themselves. On the other hand failure of intermittent rain during the process of establishment results in high seedling mortality.

5.3.5. LEAF SHEDDING AND DECIDUOUS LEAFLESS STAGE

Except *A.oblongum* all other species are deciduous with *A.laevigatum* being semi-deciduous in its lower altitudinal reaches and deciduous in its higher reaches. In all the species except *A.thomsonii* the shedding of the leaves occur just prior to the arrival of the cold harsh winters, during which the trees remain naked. It is observed that the duration of this leafless dormant stage remains longest in the species occurring in the higher altitudes which was 144-152 and 128-142 days in case of the sub-alpine species like *A.acuminatum* and *A.stachyophyllum*. From Table 5(a) it can be observed that the duration of this phase is also related to the altitude with those species that occur in higher altitudes having longer deciduous phase. Even within the same species it is observed those growing at its upper altitudinal reaches shed their leaves 7-10 days earlier than those in the lower reaches. Moreover, in some species like *A. campbellii, A. laevigatum, A. thomsonii* it was observed that young seedlings do not fully shed their leaves. Instead the terminal clusters become compacted and turn reddish and are retained until the emergence of new leaves the following year when they are shed. Thus, from the overall results obtained it can be said that `deciduousness is related to increasing winter severity' (Wardle, 1972) is appropriately established by the different species of *Acer* of the region. The different species remaining leafless leading to dormancy during the harsh winter (November-February) in the lower reaches, that often extending to April in the higher altitudinal reaches. The sprouting of the leaves and floral buds due to altitude and the micro-environment of the site for the same species where the climatic severity persists for relatively longer period may be responsible for the late sprouting and early leaf drop at higher altitudes. Thus, the decreasing temperature related to altitude have direct bearing on the temporal differentiation of phenophases. The rising temperature in early spring induces the breakage of dormancy with induction of growth as temperature rises with the decline of temperature terminating it and leading to leaf and fruit drop and ultimately leading dormancy to set in.

TABLE 5.1. THE MAJOR PHENOPHASES IN THE DIFFERENT SPECIES OF *Acer* L. OF THE DARJILING-SIKKIM HIMALAYAS

NAME OF THE SPECIES	TIME OF INITIATION OF		TIME OF SEED SETTING	TIME OF FALL OF			DURATION OF FLOWERING IN DAYS	% OF FRUIT SETTING (20 DAYS)	% RETENTION OF FRUITS (50 DAYS)	FALL COLOUR OF LEAF	DURATION OF DECIDUOUS PHASE IN DAYS	TIME OF SEED GERMINATION
	LEAVES	INFLOR.		BRACTS	LEAVES	FRUITS						
A. acuminatum	2nd –3rd wk May	end May mid June	mid-end Jun	end May	2nd wk Nov.	mid Dec-mid Jan	14-19	57.14 63.27	33.10 44.9	Red, yellow	144-152	-
A. campbellii	2nd–3rd wk Apr.	end Apr- 1st wk May	end May 1st wk.Jun.	1st wk May	2nd wk Dec 1st wk Jan	Dec – mid Mar.	23-27	93.63 95.59	83.52 82.84	Yellow Brown	96-105	4th wk Apr – mid May
A.caudatum	end Apr – 1st wk May	end Apr. - 1st wk.May	end May	3rd-4th wk May	2nd wk Nov -1st wk Dec	end Dec-mid Feb	17-21	79.03 80.56	53.23 48.61	Orange Brown	134-141	end May – early Jun
A. hookeri	end Mar-2nd wk Apr	end Mar-2nd wk.Apr	end Apr.	2nd wkApr end Apr	3rd wk Nov.	Dec - Feb.	19-23	81.28 87.39	72.15 73.42	Yellow, Reddish Brown	92-111	4th wk Apr – mid May
A. laevigatum	2nd wkApr end Apr.	2nd wkApr end Apr	3rd – 4th wk May	end Apr-1st wkMay	mid Dec-mid Jan	Oct - Jan	21-25	80.56 82.88	66.67 71.17	Yellow, orange	87-103	4th wk Apr – mid May
A. oblongum	3rd wk Apr 1st wkMay	3rd wk Apr 1st wkMay.	end Apr 2nd wkMay	-	Few mid-Dec-Feb	mid-Feb-mid Apr.	10-14	76.96 82.18	68.59 72.75	Lightgreen Brown	-	4th wk Apr – mid May
A.osmastonii	2nd–3rd wk Apr.	1st – 2nd wk. May	end May 1st wk Jun	1st-2nd wk May	3rd wk Dec mid Jan	Dec-Jan	17-21	86.41 83.65	78.70 75.96	Yellow, Brown	94-109	4th wk Apr – mid May
A.palmatum	2nd–3rd wk. Feb.	2nd–3rd wk. Feb	3rd wk Feb 1st wk Mar	3rd wk Mar	2nd wk Nov 1st wk Dec	end Nov-end Dec	10-14	82.93 88.52	70.73 67.21	Yellow,Red Brown	67-78	4th wk Apr – mid May
A.pectinatum	3rd-4th wk. Apr.	3rd-4th wk. Apr	1st -2nd wk May	end Apr-1st wkMay	2nd wkNov 3rd wk Dec	mid Dec-Feb	19-24	77.11 81.94	69.88 65.28	Yellow,Red Brown	110-117	end May – early Jun
A. sikkimense	end Feb. 1st wk Mar	end Feb. 1st wk Mar	1st-3rd wk Mar.	1st-3rd wk Mar.	3rd wk Nov 1st wk Jan	mid Jan-mid Mar	17-21	94.23 90.58	87.63 89.23	Yellow,Red Brown	72-81	4th wk Apr – mid May
A.stachyophyllum	2nd – 3rd wk May	2nd – 3rd wk May	1st-2nd wk Jun	3rd-4th wk May	1st-3rd wk Nov.	mid Nov-mid Jan	15-19	64.38 68.62	57.60 59.26	Yellow, Red Brown	128-142	-
A. stenculiaceum	end Apr-1st wk May	end Apr. 1st wk May	mid May	2nd wk-3rd wkMay	end Nov	end Dec-Jan	17-21	70.97 78.57	58.45 59.52	GreenBrown Red,Yellow	118-127	end May – early Jun
A. thomsonii	1st–2nd wk Nov.	1st–2nd wk Nov.	4th wk Nov 1st wk Dec	3rd-w-4th wk Nov.	1st-3rd wk Sep	mid Jun-mid Sep	17-19	80.36 87.10	67.86 75.81	Green, brown	45-58	mid Dec – 1st wk Jan.