

margin or edge, with each bundle carrying a fibrous cap on its outer side. The vascular bundles paralleling the heavy margin of the wing, meet the thinner and lighter margin more or less at a right or a skew angle, being connected by a great many anatomoses. The fruit corresponds to a samaroid schizocarp splitting into two one-winged mericarps at maturity. The line of separation at the centre of the fruit consists of several rows of small cells with delicate walls being flanked on both sides by mechanical tissue. The form of the wings and its size varies in different species along with the angle at which the two wings are placed relatively to one another. These characteristics have been utilised by Banerji *et al* (1971) to differentiate different species.

The seeds or the nutlets are usually round to oval, with smooth, hairy or veined surfaces. Usually two ovules occur in each locule with only one developing after fertilisation with occasionally both the ovules developing. Ogata (1967) considered that the shape of the nutlet as an important means of identification of the species. However, many others are of the opinion that this is a daunting task where the help can only be derived to a highly knowledgeable acerologist. including D. M. van Geldren *et al* (1995), Parthenocarpy, regarded as an advanced characteristic is exhibited by some taxa. Their seedless empty fruits are practically indistinguishable from the seed-bearing fruits. Oterdoom (1990)

Rehder (1905), has classified the cotyledons of *Acer* based upon the manner they remain folded within the seeds as being either '*incumbent*' or as '*accumbent*'.

Kaniewski and Wazynska (1970) report that in *A. pseudoplatanus* the endocarp develops by periclinal division of the inner epidermis. Moreover, they found unicellular hairs arising from the inner epidermis showing plasma circulation and having the function of maintaining a high moisture level within the locule. Club shaped pluricellular glandular hairs with viscous secretions and unicellular hairs of variable forms occur in the outer epidermis. A large number of workers have carried out a wide range of experiments on the aerodynamic aspects of the samara of some of the species of *Acer*. (Norberg, 1973 ; Iversen, 1979; Greene and Johnson ,1990; Walker, 1981) Through their experiments they have been able to show that wind is essential for the wide dispersal of the samara and in its absence the samara do not get very far from the parent plant. Thus, the release of the fruits during the winter when the trees are bare are advantageous as the mean wind velocity in a deciduous canopy is less in spring as compared to the winter due to the drag of emerging leaves. The autorotation of the samara ensure that the mericarps fall vertically downward which ensures a better chance of survival as the heavier locules enclosing the seeds land first.

A number of workers have worked on the vegetative propagation of various species of *Acer*, that include cutting, grafting and even micropopagation in some of the ornamental species and varieties. The degree of success is variable from species to species and even within cultivars of the same species (Savella, 1971;Vertrees,1972 Orton, 1978). In case of grafting experiments it has been found that it is successful in only closely related species. In the present work the morphological aspects of the fruits the different species including the size and the shape of their fruits and seeds, germination and seedling morphology of some of the species (where the germination could be achieved under laboratory conditions) have been described below in an alphabetical order. The overall characteristics have been tabulated in Table 6.1. Trails for vegetative propagation utilizing cuttings of soft twigs and hard wood were made at Darjiling (2200m) during the month of April and the result obtained for the different species have been tabulated in Table 6.2.

6.2. SYSTEMATIC DESCRIPTION OF FRUIT SEED GERMINATION AND VEGETATIVE PROPOGATION

Acer acuminatum Wallich ex D.Don.

FRUITS AND SEEDS

Samaras erect placed on a 8-12.5 cm long panicle axis; mericarps divergent, 2.1-2.6 x 1-1.4cm; wings pinkish when young turning light brown at maturity, glabrous, inner margin convex, crenulate , curved upwards at the upper end, outer margin straight slightly curved 1.9-2.1 x 1-1.4 cm, divergent, wing divergence 67-70°; surface & locules convex, ovoid, 0.5-0.6 x 0.3-0.35 cm; nut ovoid , convex, 0.5-0.55 x 0.2-0.3, seed coat brown: cotyledons c. 0.3 x 0.2 cm yellowish green, showing incumbent folding; radicle, white c. 0.05 cm long; plumule yellowish c. 0.03 cm.

GERMINATION

Seed germination could not be achieved in laboratory conditions.

VEGETATIVE PROPAGATION

Soft wood cuttings treated with rooting hormone showed a moderate degree of rooting in a few specimens though the rooting was much delayed as compared to other species which rooted easily.

Note:

1. A very high percentage of parthenocarpic fruits were observed.
2. Germinating seedling not found during field collection.
3. Rooting could not be obtained in the case of hard wood cuttings.

Acer campbellii Hook. f. & Thomson ex Hiern

FRUITS AND SEEDS

Samaras erect placed on a 14-16 cm long panicle axis; mericarps divergent, 2.5-3.1 x 1-1.4 cm; wings yellowish green when young turning light brown at maturity, 1.8-2 x 1-1.1 cm, glabrous, inner margin convex, contracted at the base on the inner side and abruptly broadened upwards with outer margin straight and slightly curved at apex which is more or less truncate, wings divergent, wing divergence 70-130°; surface, locules convex, ovoid, 0.55-0.6 x 0.3-0.4 cm, seed coat brown, cotyledons yellowish green 0.6x0.3 cm showing incumbent folding: radicle white c. 0.1 cm long, plumule yellowish c. 0.06 cm.

GERMINATION

Germination 71.11% ± 1.53; epigeal, phanerocotylar; tap root long, thin, creamy white, 1.3-1.5 cm, often replaced by lateral roots at later stage; hypocotyls curved at the apical end at the time of emergence creamish white 1.8-2 cm, with the curved portion 0.6-0.8 cm, slightly swollen at the base: paracotyledons two, opposite, persistent upto the two leaved stage, initially yellowish green turning green on exposure and finally shriveling off after turning yellowish, 1.6-1.8 x 0.8-cm exstipulate with short c. 0.1 cm petiole; first pair of leaves, simple, exstipulate five lobed, reddish green, serrated, acuminate, 0.4-0.6 x 0.15-0.2 cm, pubescent, primary veins 5; stem hardens from basal portion upwards turning reddish green then brownish when 1.9-2.1 cm.

VEGETATIVE PROPAGATION

Propagation by soft and hardwood cuttings treated with rooting hormones unsuccessful.

Note:

1. Naturally germinated seedlings were observed in a number of places in the field during end of April to the middle of May. However seedling mortality was high prior to hardening of the stem and both excess and low water content were found to be detrimental. Moreover, the mortality was very high under shade and loamy soil. It showed better rate of survival in open sandy soil. (Plate 6.1. t)
2. Grafting on seedlings of *A. palmatum* are reported to produce superior specimens (van Gelderen, 1994).

Acer caudatum Wallich

FRUITS AND SEEDS

Samara erect placed on a 11-14 cm long pendant raceme; mericarps ascending narrowly divergent, 2.2-2.5 x 0.8-1.2 cm; wings narrowly divergent, angle of divergence 37-40° pinkish

brown at maturity, 1.8-2 x 0.8-1.2 cm, glabrous, inner margin straight at the base, outer margin rectilinear, curving upwards and then forming a flattened apical portion which is slightly convex and crenulate; locules flattened, ovoid, with a groove, c. 0.55-0.6 x 0.35-0.4 cm; style and stigma persistent even in mature fruit; seed coat brown, cotyledons yellowish white, 0.35-0.4 x 0.25 cm showing accumbent folding; radicle white c.a. 0.05 cm; plumule 0.03cm yellowish.

GERMINATION

Seed germination could not be achieved in the laboratory conditions.

VEGETATIVE PROPAGATION

Soft and hard wood cuttings treated with rooting hormone unsuccessful.

Note:

- 1 Few naturally germinated seedlings were observed in a number of places during field collection during end of May and early June but the rate of seedling mortality is very high.
- 2 A very high percentage of parthenocarpic fruits which were seedless were observed.

***Acer hookeri* Miquel**

FRUITS AND SEEDS

Samaras horizontally placed on a pendant raceme 9-11 cm long; mericarp divergent, 1.7-1.8 x 0.4-0.5 cm; wings greenish when young turning light brown at maturity, 1.4-1.6 x 0.5-0.6 cm, glabrous, inner margin slightly crenulate, convex, outer margin straight, acute; divergence angle 45-47°; locules convex, ovoid, c.. 0.35-0.4 x 0.25-0.3 cm; seed coat dark brown, cotyledons creamish-white 0.3 x 0.2 cm, showing accumbent folding; radicle white c. 0.05 cm; plumule 0.02 c. cm yellowish- white.

GERMINATION

Germination percentage 64.4% \pm 1.15, epigeal, phanerocotylar; tap root long and thin, creamy white 0.7-0.9 cm, branched but more often replaced by 2-3 adventitious roots arising from the base of stem, at later stage; hypocotyls curved at the apical end at the time of emergence pinkish white 0.7-0.9 cm, with the curved portion 0.3-0.35 cm, slightly swollen at the base, paracotyledons two, opposite, persistent upto the two leaved stage, initially yellowish green turning green on exposure and finally shriveling off after turning yellowish, ovate, 0.6- x 0.4 cm, exstipulate with short c. 0.05 cm petiole; first pair of leaves simple, exstipulate distantly 3 lobed, light green, margin serrated, apex acuminate, 0.4-0.5 x 0.2-0.25 cm, glabrous, primary vein 3; stem hardens from basal portion upwards turning reddish green then brownish when 1.1-1.3 cm. (Plate 6.1. j)

VEGETATIVE PROPAGATION

Propagation by hard wood cuttings treated with rooting hormones moderately successful, however for soft twigs it was unsuccessful.

Note:

1. Naturally germinated seedlings were observed in a number of places during field collection during end of April to the middle of May. Seedling mortality high.
2. Seedling observed on barks of larger trees in a number of sites like Neora, Chitray, Gairibans, Bakhim, where some specimens were observed growing epiphytically on larger trees of *Rhododendron* spp. and *Quercus* spp. with some even in flowering and fruiting in this condition. (Plate 4.1.k)
3. Grafting to other species of section *Macrantha* not successful probably due to low quality of scion. (van Gelderen, 1994)

Acer laevigatum Wallich

FRUITS AND SEEDS

Samaras horizontally placed on a 8-11 cm long pendant panicle; mericarps divergent, 2.3-2.7 x 0.7-0.8 cm; wings greenish when young turning reddish to light brown at maturity, 1.8-2.1 x 0.7-0.8 cm glabrous, inner margin convex, outer margin straight, slightly curved near the apex, acute, divergent, angle of wing divergence 35-40°; locules convex, ovoid to oblong, c. 0.5-0.7 x 0.3-0.35 cm, seed coat dark brown, cotyledons yellowish, 0.5 x 0.3 cm, showing incumbent folding; radicle 0.07cm long, plumule yellowish white c. 0.03 cm.

GERMINATION

Germination 88.89% ± 0.58 epigeal, phanerocotylar; tap root long thin creamy white 1.1-1.4 cm, branched but more often replaced by 3-4 adventitious roots arising from the base of stem, at later stage; hypocotyls curved at the apical end at the time of emergence creamish- white 1.4-1.6 cm, with the curved portion 0.4-0.5 cm, slightly swollen at the base, paracotyledons two opposite persistent to the two leaved stage, initially yellowish green turning green on exposure and finally shriveling off after turning yellowish, ovate, 1.4- x 0.6 cm exstipulate with short petiole c. 0.06 cm; first pair of leaves, simple, exstipulate, unlobed, light green, margin serrated, apex acuminate, slightly unequal one slightly larger and curved more 0.6-0.8 x 0.06-0.1 cm, pubescent, primary vein 3; stem hardens from basal portion upwards turning reddish green then brownish when 1.6-1.8 cm. (Plate 6.1.p)

VEGETATIVE PROPAGATION

Trails for vegetative propagation by soft and hard wood cuttings treated with rooting hormones

were unsuccessful.

Note:

1. Naturally germinated seedlings were observed in a number of places in the field during end of April to the middle of May. Seedling survival was moderate in both shaded and open areas.
2. One seeded samaras with one of the mericarps being smaller and devoid of seeds occur occasionally (Plate 6.1. g)
3. Grafting onto *A. palmatum* produces stronger plants. (van Gelderen, 1994).

***Acer oblongum* Wallich ex. DC.**

FRUITS AND SEEDS

Samaras erect placed on a 13-16 cm long corymbose axis; mericarps divergent, 2.5-2.8 x 1-1.1cm; wings greenish and pubescent when young turning light brown at maturity, 1.8-2 x 1-1.1 cm, glabrous, inner margin convex, outer margin straight convex near the apex, apex rounded,, wings nearly parallel to slightly divergent, 20-25°; locules enclosed by thick hard pericarp with clefts covered with dense white hairs in the inner surface, 0.25-0.3 x 0.3 cm; nuts convex, angular c. 0.15-0.2x 0.15-0.2 cm, seed coat brown, cotyledons greenish yellow, 0.15 x 0.1 cm, showing incumbent folding, radicle, white, c. 0.01 cm; plumule <. 0.01cm yellowish.

GERMINATION

Germination 44.44 % ± 2.08, epigeal, phanerocotylar; tap root long thin creamy white 0.7-1 cm, branched with 3-4 lateral roots; hypocotyls curved at the apical end at the time of emergence creamish white 0.7-0.9 cm, with the curved portion 0.3-0.4 cm, slightly swollen at the base, paracotyledons two opposite persistent to the two leaved stage, initially yellowish green turning green on exposure and finally shriveling off after turning yellowish, ovate, 0.6- x 0.4 cm exstipulate with short c. 0.03 cm petiole; first pair of leaves, simple, exstipulate unlobed, upper surface bluish-green lower surface greenish-white, thin membranous, entire, acuminate with a long acumen, 0.3-0.4 x 0.08-0.1 cm, glabrous, primary vein 1; stem hardens from basal portion upwards turning brownish when 1.1-1.2 cm. (Plate 6.1.i & q)

VEGETATIVE PROPAGATION

Trails for propagation by hard wood cuttings treated with hormones gave moderate results, however soft twigs failed to root.

Note:

1. Naturally germinated seedlings were observed in a number of places during field collection during end of April to the middle of May. Rate of seedling mortality very high.

2. Fusion of carpels common with 3-4 winged samara very frequent. (Plate 6.1.d)
3. The frequency of parthenocarpic fruits very high that cannot be distinguished externally but are seedless.

***Acer osmastonii* Gamble**

FRUITS AND SEEDS

Samaras horizontally placed on a 13-18 cm panicle; mericarps divergent, 3-3.2 x 1.1-1.3 cm; wings reddish when young turning light brown at maturity, 2.5-2.8 x 1.1-1.3 cm, glabrous, inner margin convex, entire, outer margin straight convex near the apex, apex rounded; wings divergent, angle of wing divergence. 68-70°; locules ovoid, convex, 0.7-0.9 x 0.5-0.6 cm; nuts convex, seed coat brown, cotyledons yellowish 0.65 x 0.4 cm, showing incumbent folding; radicle 0.12 cm long, plumule yellowish c. 0.08 cm.

GERMINATION

Germination 77.78% ± 1.15 epigeal, phanerocotylar; tap root long, moderate, creamy-white 1.3-1.6 cm, branched but more often replaced 4-5 adventitious roots arising from the base of stem at later stage; hypocotyls curved at the apical end at the time of emergence, creamish white 1.6-1.7 cm, with the curved portion 0.6-0.65 cm, slightly swollen at the base, paracotyledons two, opposite persistent to the two leaved stage, initially yellowish green turning green on exposure and finally shriveling off after turning yellowish, ovate, 1.7- x 0.8 cm exstipulate with short petiole c. 0.07- 0.08 cm; first pair of leaves simple, exstipulate, unlobed, to three lobed, light green, margin serrated, apex acuminate, curved, 0.1-0.11 x 0.7-0.8 cm, slightly pubescent, primary vein 3; stem hardens from basal portion upwards turning reddish green then brownish when 1.6-1.8 cm. (Plate 6.1. k & n)

VEGETATIVE PROPAGATION

Trails for propagation by soft and hard wood cuttings treated with rooting hormones were unsuccessful

Note:

1. Naturally germinated seedlings were observed during end of April and May with mortality under shade being 100% and few surviving in open well drained soil.
2. It is difficult to differentiate seedlings with unlobed leaves with those of *A. laevigatum*.
3. Three winged samara frequent. (Plate 6.1.h)

***Acer palmatum* Thunberg ex Murray**

FRUITS AND SEEDS

Samaras erect placed on a 5-7 cm long corymb; mericarps ascending narrowly divergent, 1.2-1.4 x 0.4-0.45 cm; wings pinkish to reddish when young turning brown at maturity, 0.9-1.1 x 0.4-0.45 cm, glabrous, inner margin convex, outer margin convex, acute; locules convex rounded, c.a. 0.15-2 x 0.13-0.15 cm, wings divergent, angle of wing divergence c. 23-25°; nuts convex; seed coat brown, cotyledons 0.1 x 0.06 cm, yellowish green showing accumbent folding.

GERMINATION

Germination 62.22% ± 0.58, epigeal, phanerocotylar; tap root long thin creamy white 0.5-0.8 cm, branched but more often replaced by 2-3 adventitious roots arising from the base of stem at later stage; hypocotyls curved at the apical end at the time of emergence, creamish white 0.4-0.5 cm, with the curved portion 0.1-0.2 cm, slightly swollen at the base, paracotyledons two opposite persistent to the two leaved stage, initially light green turning green on exposure and finally shriveling off after turning yellowish, ovate, 0.45-0.55 x 0.15-0.2 cm exstipulate with short petiole c.a. 0.05 cm; first pair of leaves simple, exstipulate, deeply 5-7 lobed, light green, serrated, acuminate, curved 0.5-0.7 x 0.4-0.5 cm, petiolate, petiole c.a. 0.1cm, glabrous, primary veins 5; stem hardens from basal portion upwards turning reddish green and then brownish when 0.8-1 cm. (Plate 6.1.m)

VEGETATIVE PROPAGATION

Trails for propagation by soft and hard wood cuttings treated with rooting hormones unsuccessful.

Note:

1. Germination of seeds rare in natural conditions. Few seedlings observed at the end of April and May with no survival by June.
2. Fruits amongst the smallest in the genus. (van Gelderen, 1994).

***Acer pectinatum* Wallich ex Nicholson**

FRUITS AND SEEDS

Samaras erect placed on a 9-13 cm long pendant raceme; mericarps ascending narrowly divergent, 2.2-2.5 x 0.7-1 cm; wings narrowly divergent, pinkish when young turning pinkish brown at maturity, 1.8-2 x 0.7-1 cm, glabrous, inner margin straight at the base, outer margin rectilinear, curving upwards and then forming a flattened apical portion which is slightly convex and crenulate, angle of divergence 35-40°; locules flattened, ovoid, with a groove, c. 0.5-0.55

x 0.3-0.35 cm; style and stigma persistent even in mature fruit, seed coat brown, cotyledons creamish white 0.35 x 0.2 cm showing accumbent folding; radicle white c. 0.05 cm; plumule 0.03cm creamish white.

GERMINATION

Germination 46.64% \pm 2.0, epigeal, phanerocotylar; tap root long, thin, creamy white, 0.9-1 cm, branched with lateral roots; hypocotyls curved at the apical end at the time of emergence, pinkish white 0.6-0.75 cm, with the curved portion 0.3-0.35 cm, slightly swollen at the base, paracotyledons two, opposite, persistent to the two leaved stage, initially yellowish green turning green on exposure and finally shriveling off after turning yellowish, ovate, 0.75- x 0.4 cm, exstipulate, sub sessile; first pair of leaves simple, exstipulate, 3 lobed, light green, serrated, acuminate, 0.5-0.6 x 0.4-0.45 cm, pubescent, primary veins 3; stem hardens from basal portion upwards turning reddish green then brownish when 1.3-1.5 cm.

VEGETATIVE PROPAGATION

Trails for propagation by hard wood cuttings treated with rooting hormones were moderately successful those using soft twigs were unsuccessful. (Plate 6.1. s)

Note:

1. Naturally germinated seedlings were observed in a number of places during field collection during end of May to middle of June. Survival higher in moist open spaces amongst mosses.
2. A brownish exudate leaches out during germination of the seeds along with fragmented pieces of the seed coat.
3. Shows a moderate degree of parthenocarpic fruits.
4. Grafting to other species of section *Macrantha* is a good substitute and a means by which the hardier variants can be propagated and maintain the purity of the species. (van Gelderen, 1994)

Acer sikkimense Miquel

FRUITS AND SEEDS

Samaras horizontally placed on a 13-16 cm long pendant raceme; mericarps divergent, 2-2.2x 0.6-0.7 cm; wings greenish when young turning light brown at maturity, 1.7-1.9 x 0.5-0.6 cm, glabrous, inner margin slightly crenulate convex, outer margin straight, with apex slightly upturned acute, angle of wing divergence 44-46°; locules slightly flattened, ovoid, c. 0.4-0.5 x 0.3-0.4 cm; nuts ovoid, seed coat dark brown, cotyledons yellowish green, 0.35 x 0.25 cm,

showing accumbent folding, radicle white c. 0.04 cm; plumule c. 0.03 cm yellowish.

GERMINATION

Germination 75.56%± 1.53 epigeal, phanerocotylar; tap roots long, thin, creamy white 0.9-1 cm, branched with lateral roots; hypocotyls curved at the apical end at the time of emergence pinkish white 0.6-0.75 cm, with the curved portion 0.3-0.35 cm, slightly swollen at base, paracotyledons two opposite persistent to the two leaved stage, initially yellowish green turning green on exposure and finally shrivelling off after turning yellowish, ovate, 0.75- x 0.4 cm, exstipulate sub sessile; first pair of leaves simple, exstipulate unlobed, light green, serrated, acuminate, 0.5-0.6 x 0.4-0.45 cm, pubescent, primary veins 3; stem hardens from basal portion upwards turning reddish green then brownish when 1.3-1.5 cm.

VEGETATIVE PROPAGATION

Trails for propagation moderately successful in hard wood cuttings treated with rooting hormones but unsuccessful in the case of soft twigs. (Plate 6.1.u)

Note:

1. Naturally germinated seedlings were observed in a number of places during field collection during end of April to the middle of May. Rate of seedling mortality very high.

Acer stachyophyllum Hiern

FRUITS AND SEEDS

Samaras horizontal on short 7-9 cm long racemes; mericarps narrowly divergent, 2.1-2.5 x 1-1.4cm; wings reddish when young turning light brown at maturity, 1.9-2 x 1-1.4 cm, glabrous, inner margin convex, curved upwards at the upper end, apex rounded, outer margin slightly curved, angle of wing divergence c. 35-37°; surface and locules flattened, ovoid, c. 0.45-0.5 x 0.35-0.4 cm, nuts veined seed coat brown, cotyledons yellowish green, 0.3 x 0.25 cm, showing accumbent folding.

GERMINATION

Seed germination could not be achieved in the laboratory.

VEGETATIVE PROPAGATION

Trails for propagation on soft wood cuttings treated with rooting hormone showed a moderate degree of rooting. (plate 6.1.v)

Note:

1. Development of a very high percentage of parthenocarpic fruits were observed with most

collected fruits found to be seedless.

2. Naturally germinated seedling were not found during field collection.

***Acer sterculiaceum* Wallich**

FRUITS AND SEEDS

Samaras horizontally placed on a 28-32 cm long raceme; mericarps divergent, 4.1-4.8 x 1.3-1.5 cm; wings greenish when young turning light brown at maturity, 3.5-4 x 1.3-1.8 cm, finely pubescent, inner margin convex crenulate, outer margin straight, with rounded apex, wing somewhat divergent showing angle of divergence ca 45-47°; locules enclosed by thick woody pericarp, green, convex, ovoid, c. 0.9-1 x 0.7-0.85 cm; styles and stigmas persistent even in mature fruits, nuts veined, seed coat dark brown; cotyledons green 0.9 x 0.4 cm, showing incumbent folding.

GERMINATION

Germination 35.56% ± 1.53, epigeal, phanerocotylar; tap root long thin creamy white, 1.9-2 cm, branched with lateral roots; hypocotyls curved at the time of emergence creamish white, 2.4-2.6 cm, slightly swollen at the base; paracotyledons two, opposite, slightly unequal in length longer 2.3-2.4 x 1-1.2 cm shorter 2.1-2.3 x 1-1.2 cm, persistent to the two leaved stage, initially yellowish green turning green on exposure and finally shriveling off after turning yellowish, ovate, exstipulate, petiole c. 0.05 cm; first pair of leaves simple, exstipulate 5-7 lobed, brownish green, broadly serrate, acuminate, 1-1.3 x 0.8-1.1 cm, slightly pubescent, primary vein 5; stem hardens from basal portion upwards turning light green and then dark green when 3.5-3.7 cm.

VEGETATIVE PROPAGATION

Trials on propagation of soft and hardwood cuttings treated with rooting hormones produced moderately good result.

Note:

1. Naturally germinated seedlings were observed during the end of May to the middle of June with higher rate of survival under shade than in open conditions.
2. Germination percentage in laboratory was low with most of the seeds turning soft and pulpy on coming in contact with water.
3. Rooting at nodes of lower branches in contact with soil observed in many places.
4. Fusion of carpel is very common with fruits 3 winged observed in few cases.
5. It is possible to graft it on *A.pseudoplantanus*. (van Gelderen, 1994).

***Acer thomsonii* Miquel**

FRUITS AND SEEDS

Samaras horizontally placed on a pendant raceme 38-49 cm long; mericarps ascending parallel, 6.2-6.8 x 1.5-1.8 cm; wings green turning yellowish greenish when young turning light brown at maturity, 4.9-5.2 x 1.5-2 cm, glabrous, inner margin convex slightly crenulate, outer margin straight, with rounded apex, wing somewhat divergent or mericarp parallel sometimes overlapping or showing angle of divergence 39-42°; locules convex, ovoid, c. 1-1.1-1 x 0.8-0.9 cm; seed coat light brown, cotyledons unequal longer 1.2 x 0.5, shorter 0.8 x 0.45 cm, light green showing incumbent folding. radicle white less than 0.1 cm; plumule c. 0.08cm yellowish.

GERMINATION

Germination 57.78% ± 1.53, epigeal, phanerocotylar; tap root long, thin, creamy white 2.3-2.5 cm, branched but more often replaced by 4-5 adventitious roots arising from the base of stem, at later stage; hypocotyls curved at the time of emergence, creamish white, 2.7-3 cm, with slightly swollen at the base; paracotyledons two, opposite, slightly unequal in length, longer 2.5-2.7 x 1.1-1.2 cm shorter 2.1-2.3 x 1.1-1.2 cm, persistent to the two leaved stage, initially yellowish green turning green on exposure and finally shriveling off after turning yellowish, ovate, exstipulate, sub sessile; first pair of leaves simple, exstipulate, unlobed, ovate, light green, widely serrated, acuminate, 1.1- 1.3 x 0.5-0.6 cm, slightly pubescent, primary veins 3; stem hardens from basal portion upwards turning light green then dark green when 3.8-4 cm. (Plate 6.1.o)

VEGETATIVE PROPAGATION

Trials on propagation of hardwood cuttings treated with rooting hormones produced moderately favourable result, but were unsuccessful in the case of soft twigs.

Note:

1. Naturally germinated seedlings were observed during end of December and January with higher rate of survival under shade than in open conditions.
2. High degree of parthenocarpy observed.
3. It is possible to graft it on *A.pseudopiantanus*. (van Gelderen, 1994).

TABLE 6.1. MAJOR CHARACTERISTICS OF THE FRUITS, SEEDS & GERMINATION IN DIFFERENT SPECIES OF *Acer* OF DARJILING-SIKKIM HIMALAYAS.

Name of the species	Fruit Bearing Axis	Partheno-carpic tendency	Size of Mericarp in cm		Size of wings in cm		Angle of divergence of Wings	Nature of locale	Size of locale in cm		Type of folding of cotyledons	Time of natural germination	Germination percentage in the laboratory.	Nature of first pair of leaves	Response of soft C hardwood cuttings
			Length	Breadth	Length	Breadth			Length	Breadth					
<i>A. acuminatum</i>	Corymb	Very high	2.1-2.6	1.0-1.4	1.9-2.1	1.0-1.4	67-70°	Convex Ovoid.	0.5-0.6	0.3-0.35	Incumbent	-	-	-	Soft wood mod rooting.
<i>A. campbellii</i>	Paniculate	Weak	2.5-3.1	1.0-1.4	1.8-2.0	1.0-1.4	70-130°	Convex Ovoid	0.55-0.6	0.3-0.4	Incumbent	end of April to mid May	71.11 ± 1.53	Simple, 5-lobed, 5 Pr. vein	No rooting obtained.
<i>A. caudatum</i>	Terminal raceme	Very high	2.2-2.5	0.8-1.2	1.8-2.0	0.8-1.2	37-40°	Flat Ovoid	0.55-0.6	0.35-0.4	Accumbent	end of May to early June	-	-	No rooting obtained
<i>A. hookeri</i>	Short Raceme	Weak	1.7-1.8	0.4-0.5	1.4-1.6	0.4-0.5	42-45°	Flat Ovoid	0.35-0.4	0.25-0.3	Accumbent	end of April to mid May	64.4% ± 1.15	Simple, 3-lobed, 3 Pr. vein	Hard wood mod. rooting
<i>A. laevigatum</i>	Lax panicle	Weak	2.3-2.7	0.5-0.7	1.8-2.1	0.5-0.7	35-40°	Convex Ovoid	0.5-0.7	0.3-0.35	Incumbent	end of April to mid May	88.89% ± 0.58	Simple, Unlobed 3 Pr. vein	No rooting obtained
<i>A. oblongum</i>	Lax cyme	High	2.5-2.8	1-1.1	1.8-2.1	1-1.1	Nearly Parallel 20-25°	Convex angular	0.35-0.4	0.3-0.35	Incumbent	end of April to mid May	44.44 % ± 2.08	Simple, Unlobed 1 Pr. vein	Hard wood mod. rooting
<i>A. osmastonii</i>	Paniculate	Weak	3-3.2	1.1-1.3	2.5-2.8	1.1-1.3	68-70°	Convex angular	0.7-0.9	0.5-0.6	Incumbent	end of April to mid May	77.78% ± 1.15	Unlobed -3-lobed 3 Pr. vein	No rooting obtained
<i>A. palmatum</i>	Pendant Corymb	Weak	1.2-1.4	0.4-0.45	0.9-1.1	0.4-0.4	23-25°	Convex Ovoid	0.15-0.2	0.13-0.1	Incumbent	end of April to mid May	62.22% ± 0.58	5-7 lobed 5 Pr. vein	No rooting obtained
<i>A. pectinatum</i>	Loose Raceme	Moderate	2.2-2.5	0.7-1	1.8-2	0.7-1	35-40°	Flat Ovoid	0.5-0.55	0.3-0.35	Accumbent	end of April to mid May	46.64% ± 2.0	Simple, 3-lobed 3 Pr. vein	Hard wood moderate rooting
<i>A. sikkimense</i>	Spicate Raceme	Weak	2-2.2	0.6-0.7	1.7-1.9	0.6-0.7	44-46°	Flat Ovoid	0.4-0.5	0.3-0.4	Accumbent	end of April to mid May	75.56 ± 1.53	Simple unlobed 3 Pr. vein	Hard wood moderate rooting
<i>A. stachyophyllum</i>	Short Raceme	High	2.1-2.5	1-1.4	1.9-2	1-1.4	35-37°	Flat Ovoid	0.45-0.5	0.35-0.4	Accumbent	-	-	-	Soft wood moderate rooting
<i>A. sterculiaceum</i>	Pendulous Corymbs	Moderate	4.1-4.8	1.3-1.5	3.5-4	1.3-1.	44-46°	Convex Ovoid	0.9-1	0.7-0.85	Incumbent	end of April to mid May	35.56% ± 1.53	5-7 lobed 5 Pr. vein	Soft & Hard moderate rooting
<i>A. thomsonii</i>	Pendent Raceme	High	5.5-6.2	1.5-2	4.9-5.2	1.5-2	Parallel to 39-42°	Convex Ovoid	1-1.1	0.8-0.9	Incumbent	end Dec. to early Jan.	57.78% ± 1.53	Simple unlobed 3 Pr. vein	Hard wood moderate rooting

TABLE 6.2. RESULT OF TRAIL WITH ROOTING OF SOFT AND HARD TWIGS OF THE DIFFERENT SPECIES OF *Acer* OF THE DARJILING- SIKKIM HIMALAYA

NAME OF THE SPECIES	TRAILS ON SOFT TWIG				TRAILS ON HARD WOOD			
	No. of cuttings taken	No. of cuttings rooting	% of rooting	No. of days Taken for Root emergence	No. of cuttings taken	No. of cuttings rooting	% of rooting	No. of days Taken for Root emergence
<i>A. acuminatum</i>	30	10	33.33	43-45	30	0	0	-
<i>A. campbellii</i>	30	0	0	-	30	0	0	-
<i>A. caudatum</i>	30	0	0	-	30	0	0	-
<i>A. hookeri</i>	30	0	0	-	30	12	0	27-30
<i>A. laevigatum</i>	30	0	0	-	30	0	-0	
<i>A. oblongum</i>	30	0	0	-	30	09	0	27-30
<i>A. osmastonii</i>	30	0	0	-	30	0	-0	-
<i>A. palmatum</i>	30	0	0	-	30	0	-0	-
<i>A. pectinatum</i>	30	0	0	-	30	13	0	30-35
<i>A. sikkimense</i>	30	0	0	-	30	12	0	21-25
<i>A. stachyophyllum</i>	30	07	23.33	35-40	30	0	0	30-32
<i>A. sterculiaceum</i>	30	18	60.00	27-30	30	22	0	21-24
<i>A. thomsonii</i>	30	11	36.67	30-35	30	17	0	21-24

6.3. RESULT AND DISCUSSION:

6.3.1. FRUITS

The characteristic fruit of the genus is a double samara comprising of two one seeded mericarp. The different species of *Acer* show certain morphological variations with respect to certain characteristics of the samara.

The axis bearing the samaras is in the form an elongated panicle in *A. acuminatum*, *A. campbellii*, *A. laevigatum*, and *A. osmastonii*; a corymb in *A. palmatum* and *A. oblongum*; a raceme which was short in *A. stachyophyllum*, *A. caudatum* and *A. pectinatum*; elongated in *A. hookeri* and *A. sikkimense* and being highly elongated in *A. sterculiaceum* and *A. thomsonii*.

The smallest fruits were observed in case of *A. palmatum* and *A. hookeri* where the mericarps were 1.2-1.4 x 0.4-0.5 cm and 1.7-1.8 x 0.4-0.5 respectively, whereas those of *A. sterculiaceum* and *A. thomsonii* were the largest measuring 4.1-4.8 x 1.3-1.5 and 5.5-6.2 x 1.5-2 cm

respectively the other species exhibited mericarps having intermediate sizes in between the two ranges.

The wings of the samara of different species differ with respect to their form as well as with respect to the angle at which they are placed relative to each other. Banerji *et al* (1971) tried to classify the fruits of *Acer* of Nepal based on the angle of divergence. With respect to the size of the wings the smallest were found in *A. palmatum*, being 0.9-1.1 x 0.4-0.45cm where as those of *A. thomsonii* were the largest being 4.9-5.2 x 1.5-2 cm. The wings of *A. sterculiaceum* remains pubescent even at maturity with non-glandular elongate single celled hairs spread throughout the wings with those of others being glabrous. While the wings of most species remain light brown those of *A. laevigatum* are often reddish and those of *A. thomsonii* exhibit a warm brown colour at maturity. Depending upon the angle of divergence of the wings the different species could be broadly grouped into three major groups. However, while the angle of divergence is more or less constant in most species, a few like *A. oblongum*, *A. thomsonii* and *A. campbellii* show a wide variation. The wings may be set parallel to one another in *A. oblongum* (though in others it may be acute showing a divergence of 20-25°) and *A. thomsonii*, where the two wings may overlap with one mericarp being slightly shorter. However fruits where the angle of divergence may be 39-42° occur even on the same plants bearing the near parallel samara.

Class I : Angle divergence of wing very acute i.e. less than 45 °: It included species like *A. palmatum* 23-25 °, *A. stachyophyllum* 35-37°, *A. pectinatum* 35-40°, *A. laevigatum* 35-40° and *A. caudatum* 37-40°; **Class II :** Angle of wing divergence close to around 45°: It included *A. sikkimense* 44-46°; *A. hookeri* 45-47°, *A. sterculiaceum* 45-47°, **Class III** the angle of wing divergence is wide being more than 45°: It included *A. acuminatum* 67-70°, *A. osmastonii* 68-70°, and *A. campbellii* which exhibited the widest being showing a variations ranging from 70-130°.

6.3.2. PARTHENO-CARPY

Parthenocarpy, thought to be an advance character is exhibited by some of the species. While species like *A. campbellii*, *A. hookeri*, *A. laevigatum*, *A. osmastonii* and *A. palmatum* exhibited weak parthenocarpic tendencies with most of the fruits enclosing seeds the tendency was moderate in case of *A. caudatum* and *A. pectinatum*, being high in *A. oblongum*, *A. sterculiaceum*, *A. thomsonii* and the highest being in *A. acuminatum* and *A. stachyophyllum* where most of the fruits were remained to be devoid of seeds. In addition a small degree of the suppression of one

of the mericarps which remained smaller and often devoid of seeds were observed in *A. laevigatum*, *A. palmatum* and *A. thomsonii*. On the other hand fusion of carpels leading to the development of samaras with three and sometimes four mericarps were observed in *A. oblongum*, *A. sterculiaceum* and *A. laevigatum* and is highly pronounced in *A. oblongum*. In general, all the species growing in the Darjiling-Sikkim Himalayas develop fruits though the status of seed production varies. The extremely low rate of seed production i.e. the production of mostly parthenocarpic fruits, certainly have a bearing on the population structure and the conservation strategies of these species.

6.3.3. SEEDS

The seeds are either convex or flattened. Flattened seeds are observed in five of the recorded and are *A. caudatum*, *A. hookeri*, *A. pectinatum*, *A. sikkimense* and *A. stachyophyllum*. In the others the seeds are convex being more or less ovoid to rounded except for *A. oblongum* in which the seed is angular. The smallest seed is found in *A. palmatum* and *A. oblongum*, c. 0.3 cm X 0.2 cm and c.a 0.3-0.35 X 0.2 cm in respectively and the largest in *A. sterculiaceum* and *A. thomsonii*, being 0.85-0.9 x 0.6-0.7cm and 0.9-1 x 0.75-0.8 cm respectively. While the species with flattened seeds show an accumbent folding of the cotyledons those with convex seeds show incumbent infolding of their cotyledons (Rehder 1905).

6.3.4. GERMINATION

Germination of the seeds in natural conditions, for the species occurring in between 2000 to 2800 m like *A. hookeri*, *A. laevigatum*, *A. campbellii*, *A. osmastonii*, *A. palmatum*, *A. sikkimense*, were found to take place during the end of April to the middle of May, after the first few showers. However, in those occurring at higher altitudes the germination occurred in the end of May to early June as in case of *A. sterculiaceum*, *A. caudatum* and *A. pectinatum*. In the case of *A. thomsonii* which occurs in the lower reaches of the temperate region, the germination of seeds were found to occur during the end of December to early January. It was observed in laboratory conditions that the seeds under laboratory conditions easily become pulpy and soft on coming in contact with water. It may be that excessive water is not conducive for its germination and it germinates at lower temperature when the atmospheric as well as the water content in the soil surface layer after the monsoon is over in mid-September has decreased considerably. Seedlings of *A. thomsonii*, certainly have a better chance of survivability as the water relation in the low altitude area, where these species grows, generally remain comfortable as some early showers during April-May after which the monsoon begins allows these seedlings to get a longer period for their stabilization before the onset of the next

winter. The requirement of low temperature for the germination may be a residual character if its high altitude ancestor.

6.3.5. VEGETATIVE PROPAGATION

Soft and hard wood cuttings treated with rooting hormones and planted during April showed varied reactions. While species like *A. campbellii*, *A. oblongum*, *A. laevigatum* and *A. osmastonii*, did not produce roots, moderate rooting was obtained for soft twigs in *A. acuminatum*, and *A. sterculiaceum*. Hard wood rooting occurred in *A. hookeri*, *A. oblongum*, *A. pectinatum*, *A. sikkimense* and *A. sterculiaceum*. Rooting occurred rapidly after 29-31 days in *A. sterculiaceum* but was delayed and took long period over 40 days in *A. acuminatum* in which case only a few of the cuttings developed roots. However, the transfer of the cuttings to the soil showed that the degree of survival was low. The prolonged period needed in the appearance of the roots did not allow the proper establishment of the cuttings prior to the winters. This needs further experimentation. Cuttings may be grown in poly-pots in nursery at least for a year to achieve healthy saplings so that their chance of survivability increases.

Plate 6.1. FRUITS, GERMINATING SEEDS, SEEDLINGS AND ROOTED CUTTINGS OF SOME OF THE SPECIES OF *Acer* L. OF THE DARJILING SIKKIM HIMALAYA.



a. Fruiting twig of *Acer caudatum*



b. Fruiting twig of *Acer osmastonii*



c. Fruiting twig of *Acer laevigatum*



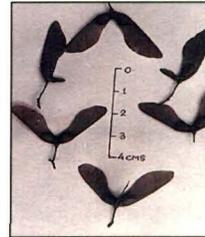
d. Fruits of *Acer oblongum* showing two and three winged samara



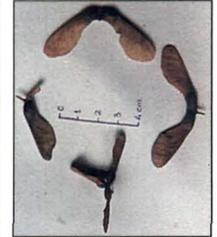
e. Normal samara of *Acer sterculiaeum*



f. 3 winged samara of *Acer sterculiaeum*



g. Samara of *Acer laevigatum* normal and one abortive



h. Two and three winged samara of *Acer osmastonii*



i. Germinating seeds of *Acer oblongum*



j. Germinating seeds of *Acer hookeri*



k. Seedlings of *Acer osmastonii*



l. Germinating seeds of *Acer campbellii*



m. Different developmental stages of the seedlings of *Acer palmatum*



n. Different developmental stages of the seedlings of *Acer osmastonii*



o. Different developmental stages of the seedlings of *Acer thomsonii*



p. Different developmental stages of the seedlings of *Acer laevigatum*



q. Two year old seedling of *Acer oblongum*



r. Two year old seedlings of *Acer laevigatum*



s. Two year old seedlings of *Acer pectinatum*



t. Naturally germinating seedlings of *Acer campbellii*



u. Hard wood rooting in *Acer sikkimense*



v. Soft wood rooting in *Acer stachyophyllum*