SUMMARY
The thesis embodies the results of observations on the developmental and structural anatomy of seeds and fruits in six Himalayan taxa of Asteraceae: *Dichrocephala latifolia* DC. (Grangeineae), *Erigeron multicaulis* DC. (Heterochromaeae), *Galinsoqa parviflora* Cav. (Galinsogeae), *Tagetes minuta* Linn. (Helenieae), *Cnicus arvensis* Hoffm. (Carduineae) and *Gerbera lanuginosa* Benth. (Gerbereae). In addition, a comprehensive histochemical investigation dealing with the localization of insoluble polysaccharides, total proteins and RNA during progressive stages of seed development and maturation has been undertaken in *Galinsoqa parviflora*. All these taxa were collected from the plants growing wild in the hills of Shimla, Ghanahatti (District Shimla) and Chambaghat (District Solan).

Morphologically these plants appear alike in possessing capitula; involucre of green bracts; sygenesious stamens; bicarpellary, inferior ovary with a single basal ovule and cypsella fruit. Nevertheless, the heads are 'radiate' in *Erigeron multicaulis*, *Galinsoqa parviflora*, *Gerbera lanuginosa* and *Tagetes minuta* and 'discoid' in others.

Anthers are bisporangiate in *Dichrocephala latifolia* and *Erigeron multicaulis* and tetrasporangiate in *Cnicus arvensis*, *Galinsoqa parviflora*, *Gerbera lanuginosa* and *Tagetes minuta*. Of the four microsporangia, one or two
sporangia are atrophied in some anthers of G. parviflora. Development of the anther wall conforms to the Dicotyledonous type in all the species presently investigated. The young anther wall comprehends four layer of cells, viz., epidermis, endothecium, middle layer and tapetum. The latter is dual in origin and remains uninucleate but rarely becomes binucleate in D. latifolia and E. multicaulis. In later stages the middle layer degenerates and the anther tapetum forms true periplasmodium. At maturity, the epidermis persists and endothecial thickenings develop in the sub-epidermal layer. Microspore mother cells are uniseriate in C. arvensis, G. parviflora, T. minuta; uni- and/or bi-, seriate in G. lanuginosa, E. multicaulis and uni-, bi- and /or tetra, seriate in D. latifolia. Meiosis is normal and cytokinesis is of the simultaneous type resulting in a variety of microspore tetrads which are tetrahedral in E. multicaulis; decussate and tetrahedral in G. parviflora, T. minuta; tetrahedral, decussate and isobilateral in C. arvensis, D. latifolia and G. lanuginosa. A tendency towards degeneration of one of microspores of the tetrad and occurrence of pentad have also been sporadically observed in G. lanuginosa. Mature pollen grains are spheroidal and three-celled. The exine shows small projections in D. latifolia, E. multicaulis, G. parviflora and T. minuta and smooth-walled in others.
The ovary is bicarpellary, syncarpous and unilocular with a single unitegmic, tenuinucellate and anatropous ovule. In a few cases of *Galinsoga parviflora* and *Gerbera lanuginosa* two ovules have been found. The only integument is collectively formed from the cells of dermatogen, sub-dermatogen and inner core in all the taxa presently studied. Micropylar passage is straight. Micropylar obturator differentiates in *Cnicus arvensis* and *G. lanuginosa*, a feature recorded for the first time in Asteraceae. The female archesporium is generally unicelled, but sometimes more than one archesporial cell occurs in *G. parviflora*. Following considerable increase in size, the hypodermal archesporium functions directly as the megaspore mother cell. Megasporogenesis usually results in a linear disposition of four megaspores; occasionally T-shaped (*G. parviflora*) and decussate (*Tagetes minuta*) tetrads are also met with. Occurrence of decussate tetrads is the first reported instance for the family Asteraceae. In addition to the tetrad, formation of triad (*G. lanuginosa*), pentad (*Erigeron multicaulis*) and triad and pentad (*Dichrocephala latifolia*) have also been encountered in a few ovules. Of the species studied, the functional megaspore is generally chalazal one. Besides that, any one of the other spores of the tetrad or pentad, often showed the potentiality of developing into the gametophyte in *G. parviflora* and *E. multicaulis*. Monosporic, Polygonum type of development was
observed in all the species. The inner layer of the integument differentiates into endothelium at triad stage in *T. minuta*; linear tetrad stage in *C. arvensis* and *G. parviflora*; 2-nucleate stage in *E. multicaulis*; and at 4-nucleate stage in *G. lanuginosa*. Cells of the endothelium are uniseriate with uninucleate organisation except for *T. minuta* where it is consistently about 4-layered. A tendency to become biseriate was also observed in a few ovules of *C. arvensis*, *D. latifolia* and *G. parviflora*.

Presently, the organised embryo sac is an elongated tubular structure whose antipodal end is narrower than the micropylar end. Egg and synergid are smooth-walled and uninucleate. Synergid haustorium occurs in *Tagetes minuta*. Two polar nuclei meet in the centre of the embryo sac or near the egg and fuse to form the secondary nucleus prior to fertilization. Antipodal cells show great variation. Multiplication of primary antipodals results in the formation of a complex of about four cells in *Cnicus arvensis* and *Galinsoga parviflora*; four to seven of which one becomes binucleate in *Erigeron multicaulis*; and five to eight in *Dichrocephala latifolia*. In addition, the lowermost chalazal antipodal cell elongates to form aggressive haustorium in *E. multicaulis*, *G. parviflora* and *T. minuta*. Due to phenomenon of 'Strike', the reduction in
the number of antipodals has also been observed in G. lanuginosa and T. minuta.

Fertilization is porogamous. Syngamy and triple fusion take place almost simultaneously. Endosperm is of the nuclear type in all the species except in Galinsoga parviflora where it is of the cellular type. Extensive endospermous haustorium differentiates at globular or heart-shaped stage of embryogeny in Erigeron multicaulis, G. parviflora, Tagetes minuta, Cnicus arvensis and Gerbera lanuginosa which perhaps act as a special device to draw nourishment from the adjoining tissue in order to cope with the increasing nutritional demand of the growing embryo leading to the better seed set. A unique feature of the present study otherwise unrecorded for the Asteraceae, is the coexistence of antipodal, synergid and endospermous haustoria in T. minuta. Differentiation of a jacket layer from the peripheral cells of endosperm is recorded for the first time in members of other tribes, Asteroideae (E. multicaulis), Helenieae (T. minuta) and Mutisiaceae (G. lanuginosa). Embryo development corresponds to Asterad type or follows Grand Period I, Series 'A' and Megarchetype II.

The seeds show scanty endosperm and a voluminous embryo (cotyledons + embryonic axis). Seed-coat is undifferentiated and comprehends non-lignified epidermal layer along with few layers of underlying sub-epidermal
layers in the present members. There is also ample evidence from the present study to show that it is the endosperm which persists in the mature seed, and not the endothelium. The mature pericarp exhibits no differentiation, excepting <i>Cnicus arvensis</i> where it is 2-zonate. Mechanical zone is absent. Numerous uni-, and bi-, celled trichomes bulge out from the epidermal cells of pericarp in <i>Galinsoga parviflora</i> and <i>Erigeron multicaulis</i>, respectively. In view of the great dissimilarities between the pericarp structures of Helenieae and Heliantheae, the present study does not support their merger as otherwise advocated by some of the taxonomists.

The results obtained were evaluated in the light of previous work in the family.

The qualitative histochemical analysis of insoluble polysaccharides, total proteins and RNA in various tissues during progressive stages of seed development in <i>Galinsoga parviflora</i> revealed that: (1) Insoluble polysaccharides appear first in the connective cells and subsequently in the epidermis, endothecium and middle layer of the anther wall; (2) Microsporocyte possesses a high amount of RNA and proteins, but lacks PAS grains; (3) Concentration of storage starch decreases in the connective and anther wall layers at about the formation of microspore tetrads; (4) Tapetum
since its inception is rich in total proteins and RNA; (5) Periplasmodium is bereft of PAS grains; (6) Fibrous endothecium gives intense staining for PAS; (7) Callosic walls of the microspores of a tetrad are PAS +ve; (8) Mature pollen grains are gorged with cytoplasmic polysaccharides, total proteins and RNA; (9) Ovular primordium stains moderately for RNA and total proteins; (10) Megasporocyte lacks storage starch; (11) Functional megaspore exhibits a high rate of metabolism as evidenced by its intense protein and RNA concentration; (12) Egg is bereft of PAS grains; (13) Cytoplasm of the egg is markedly pyroninophilic; (14) Antipodal cells possess moderate to high concentration of RNA and total proteins; (15) Antipodal haustorium exhibits intense pyroninophilic reaction; (16) Primary endosperm nucleus has RNA and proteins; (17) Endothelium and endospermous haustorium possess high contents of various macromolecules; (18) Jacket layer appears to be storage in function; (19) Embryonal cells show a higher content of various macromolecules than the suspensor cells; (20) Protein and polysaccharide grains occur abundantly in the mature dicotyledonous embryo; (21) Progressive increase in the concentration of PAS grains in the integumentary cells; (22) Ovary wall in the pre-fertilization stages is gorged with storage starch which disappear in the mature pericarp. The probable implications of all these events in relation to the development of male and female gametophytes, endosperm and embryo are discussed.