P R E V I O U S    W O R K
VEGETATIVE ANATOMY - Rushton (1915) studied wood anatomy of some Indian junipers namely, *J. recurva* Ham., *J. wallichiana* Hook. f. & Thoms (Syn. *J. excelsa* Brandis non Bieb.) and *J. communis* L. According to Rushton (1915) the general anatomical features are similar in all species. But, he has emphasized the taxonomic role of resin cells in the growth rings for identification of the species. Peirce (1937)
contributed to our knowledge of wood anatomy of 23 species of junipers. Rannan (1942) described wood structure of 3 species of junipers native to Ontario (Canada) represented by *J. communis* var. *depressa* Pursh, *J. horizontalis* Moench and *J. virginiana* L. Wood anatomy of these species follows the general pattern and does not exhibit any major difference from one another. Kaeiser (1953) worked out the microstructure of the wood of 39 species of junipers belonging to three sections of the family. Woods of different species examined have revealed features which are common to all especially the structure of tracheids, xylem parenchyma, rays and cupressoid cross-field pits (occasionally taxodioid in early wood of Section Sabina). Later on Kaeiser (1954) demonstrated that *Arceuthos drupacea* Labill. Ant. and Kosch is anatomically more aligned to junipers than to other genera of Cupressaceae. Hence, she justified the merger of *Arceuthos drupacea* with *J. drupacea* Labill. Johnsen (1963) studied the anatomy of scale-like leaves of four Arizona junipers namely *J. deppeana, J. monosperma, J. scopulorum* and *J. osteosperma*. Although the scale-like leaves of these junipers are similar, differences do occur in structural details with respect to fibre-cell layer, resin glands and cuticle. Mehra and Jain (1976) have described in detail the anatomy of five East Himalayan
taxa, namely *J. wallichiana*, *J. recurva* (sensu stricto), *J. squamata* var. *fargesii*, *J. squamata* var. *wilsonii* and *J. pseudosabina* with respect to leaf, young shoot and bark. Suzuki (1979b) studied course of resin canals in the shoots of *J. chinensis*, *J. rigida* and *J. taxifolia* var. *lutchensis*. The scale leaves as well as foliage leaves show torreyatype resin canals (Suzuki, 1979a).

The structure and organisation of shoot apex of *Juniperus* has, in the past, received attention of Groom (1885), Karsten (1886) and Koch (1891). In the recent past Al.Sherifi (1952) and A. Pillai (1963) have contributed to the understanding of the genus in this regard. The genus displays absence of a prolonged dormant period.

**CONE ANATOMY** - Aase (1915) stated that in the female strobilus of *J. communis*, bract and scale are completely fused. The anatomical details provided him evidence of the double nature of sporophylls. Mehra and Jain (1976) studied vascularisation of female cones of East Himalayan junipers; in general they agree with Aase (1915). But, according to them two circles of bundles are dispersed in the middle of spongy tissue of the sporophylls. The traces of outer circle have xylem facing
centripetally and xylem of the inner circle faces centrifugally.

**SEEDLING ANATOMY** - Hill and de Fraine (1908) studied seedling structure of *J. virginiana*, *J. cedrus* Webb. and Benth., *J. procera* and *J. bermudiana*. These four taxa differ in few structural details relatively. Barton (1951) performed germination tests on seeds and whole berries of *J. virginiana*. He has given optimum requirements for breaking dormancy.

**SEED COAT** - Mathews (1939) has studied the seed coat development in *J. virginiana* and observed that the seed has a protective stony integumentary layer. The secondary thickening of the cell walls begins in the micropyle-closing layer and progresses downwards through the middle region of the integument.

**CYTOLOGY** - Cytological studies in various taxa of junipers are those of Sax and Sax (1933), Ross and Duncan (1949), Stiff (1951), Mehra and Khoshtoo (1956), Löve and Löve (1956), Jørgenson, Sørensen and Westergaard (1958), Evans and Rasmussen (1971), Mehra (1976), Hall, Mukherjee and Crowley (1979) and Mujoo and Dhar (1981). All the above workers have recorded chromosome counts only, except Mehra and Khoshoo (1956) and Mujoo and Dhar (1981) who have studied karyotypic details in *J. procera* and *J. communis* ssp. *nana* respectively. Of the 60 *Juniperus* species, 52 taxa under 16 species have so far been
studied cytologically: 33 are diploid \((2x = 22)\),
3 are triploid \((3x = 33)\) and 16 are tetraploid
\((4x = 44)\).

**EMBRYOLOGY** - Jack (1893) briefly described
fructifications of junipers and called male flower as
a "catkin".

Staminate cones in **Juniperus communis** var. **depressa**
are formed during summer of the year preceding
In **J. virginiana** the cones appear in August and attain
their mature size by winter in eastern North America
(Matheus, 1939). Microsporangium comprises sporogenous
cells surrounded by one layered tapetum, an intermediate
layer of tubular cells and an outer epidermal layer.

Duhoux (1973) conducted ultra structural studies
on the pollen grain wall of **J. communis** during **in vitro**
pollen germination. Duhoux and Norreel (1974) cultured
and studied the pollen tissue of **J. communis** and
**J. chinensis**.

Hofmeister's (1851) investigation on **J. communis**
is the first report on the pollen tube. He remarked
that two years are required for development of the
pollen tube. He observed a large dividing cell in the
end of the tube with many smaller cells above at the
time of fertilization. He also mentions the presence
of a distinct delimiting membrane about the body cell in *J. sibirica*. His observation was subsequently substantiated by Belajeff (1893), Norén (1904, 1907) and Sludsky (1905). Hofmeister (1858) published another account of the pollen tube development and fertilization and reported the formation of multiple male cells. Strasburger (1869, 1872, 1878) found granular cytoplasm in the pollen tubes of *J. communis* and also recorded the division of large free cell into two daughter cells before fertilization in *J. virginiana*. Belajeff (1893) was the first to give a reasonable interpretation of the development of male gametophyte. Development of the male gametophyte has also been studied by Sludsky (1905), Noren (1907), Ottley (1909) and Nichols (1910). These authors have mentioned the presence of a plasma membrane or "Hautschicht" around generative nucleus. The observations of Mathews (1939) differ with regard to the timing of the division in the male gametophyte. Nichols (1910) has further observed the presence of three or four male cells. The above workers agree with respect to the absence of prothelial cells in the pollen grain.

Earlier it was stated that the female cone ("berry", Engelmann, 1877) attains maturity in two years. But Jack (1893) has reported that the period
of ripening varies in different species: one year for *J. virginiana*, two years for *J. sabina* var. procumbens and *Juniperus communis* L. ripening in three years.

Renner (1904) reported the presence of hermaphrodite cones in *Juniperus communis*.

The development of megaspore mother cell was studied by Norén (1907), Nichols (1910) and Mathews (1939) in *Juniperus communis*, *J. communis* var. depressa and *J. virginiana* respectively. All of them agree in deep seated origin of megaspore mother cell surrounded by "tapetum" or spongy tissue. Mathews (1939) observed that at the time of meiotic division of the megaspore mother cell, a permanent membrane is rarely laid down between two resulting daughter nuclei; and the lower divides further.

According to Nichols (1910) growth of female gametophyte is phenomenal after 16 free nuclei are formed in *J. communis* var. depressa.

The megaspore membrane reaches its maximum development at the time of fertilization in *J. sabina* and *J. communis* as reported by Thomson (1905), Norén (1907) and Nichols (1910).

Abnormally placed archegonia have been observed by Norén (1907) and Ottley (1909).
Considerable attention has been paid to the peculiar granular deposits which appear in the central cell shortly before its division. Norén (1907) and Nichols (1910) called these peculiar structures "Strahlungszentren" and "asteroids" respectively. Mathews (1939) also observed similar granules together with numerous cytoplasmic radiations in *J. virginiana*. Electron microscopic studies of *J. communis* by Chesnoy (1967) have revealed that "asteroids", of earlier authors, are a mass of ribosomes and microtubules surrounded by some mitochondria and plastids.

Hofmeister's "Körperchen" or proteid vacuoles have been demonstrated in egg cytoplasm of *J. communis* and *J. communis* var. *depressa* by Norén (1907) and Nichols (1910) respectively.

Strasburger (1869) states that fusion nucleus moves to the organic apex of the archegonium before division, but according to Ottley (1909) the first division occurs before the nucleus shifts its position. Development of the proembryo was studied by Norén (1907) in *J. communis*, Nichols (1910) in *J. communis* var. *depressa*, Mathews (1939) in *J. virginiana* and Tang (1948) in *J. chinensis*. They agree in details, at least up to the formation of eight free nuclei. Cook (1939) observed a new type of embryogeny of conifers in *J. communis* especially with respect to the proliferation of the embryonal suspensors.
Recently, Dogra (1978) has made a critical study of the embryogeny and has evolved a system of nomenclature.