CHAPTER II
PREVIOUS WORK

Primitive oleaceous flower

Among the present day diandrous bicarpellary flowers, some have transverse carpels and median stamens while others bear exactly the opposite condition. The position of calyx and corolla remains unaltered in both the types, therefore, Wydler (1860) concluded that a primitive flower in this family conforms to the tetrmerous plan with the formula $\Phi K_4 C_4 A_4 G (4)$. Weber (1928) made extensive investigations in the comparative morphology of the Oleaceae flower. He concluded that primitive-ly, calyx, corolla, androecium and gynoecium were each consisting of 2 bimerous whorls. Therefore, the floral formula of the hypothetical primitive flower is $\Phi K_{2+2} C_{2+2} A_{2+2} G_{(2+2)}$. 

In his opinion, Fraxinus dipetala has secondarily reduced petals.

Velenovsky (1901) and Tørgard (1924) maintained that bimery prevails in all the floral whorls \([+ 0 K_2 \text{ or } 2+2 C_2 A_2 G(2)]\). But the initial bimerous plan has been retained only in Fraxinus dipetala while in the rest, a 4-lobed corolla resulted through a splitting of the 2 primary petals (Tørgard, 1924).

Jasminum is regarded as having initially 2 corolla whorls each of which was bimerous (Eichler, 1875; Tørgard, 1924). Weber (1928) took the 2-whorled corolla of Jasminum and Schrebera as primitive in this family.

**Taxonomy**

Although over a thousand species distributed among 24 genera are listed in Index Kewensis, most taxonomists estimate about 20 genera and 400-500 species in Oleaceae. In recent years, a few genera like Parasyringa and Abeliophyllum have been included while Nyctanthes and Dimetra have been excluded from the family.

Many contributions have been made to classification, morphology and phyllogeny of Oleaceae but considerable difference of opinion still exists about systematic position and classification of the family. Among the major taxonomic treatments and monographs on 9 genera, those on Ligustrum (Mansfeld, 1924) and Schrebera (Gilg, 1901) are noteworthy. Some papers dealing with
the taxonomy of *Jasminum* are published by Kobuski (1932, 1939a, b, 1940, 1959). Taxonomic reviews of Taylor (1945), Johnson (1957) and Wilson & Wood (1959) have added to our knowledge of the classification or relationships within the family.

**Anatomy**

Mansfeld (1924) has shown that the leaf epidermis and the stem structure in the genus *Ligustrum* have some value in the recognition of its species. Schwarz (1927) studied the developmental anatomy of the leaf of *Ligustrum vulgare*. The vascular system of the stem of *Nyctanthes arbor-tristis* is studied by Potidajr (1939) and Majumdar (1941).

Joshi & Fotidar (1940, 1941) have reported many interesting features on the floral anatomy of Oleaceae. In *Olea fragrans*, the sepals are sometimes devoid of vascular supply. Further, the gynoecium is composed of 2 whorls of opposite and decussate open carpels, with ovules along their free margins. The ovaries of *Forsythia*, *Syringa* (Eames, 1931) and *Fraxinus* (Copeland, 1960) provide examples of 5-trace carpels. Ranjan (1954) reported concentric bundles in *Nyctanthes*.

The family is characterised by peltate secretory trichomes, ranunculaceous stomata, idioblasts and acicular or prismatic crystals. Absence of bicollateral bundles distinguishes this family from the rest of the Contortae. Also, absence of laticiferous tissue separates the family from Styracaceae and Ebenaceae (Metcalfe & Chalk, 1950; McLean & Ivimey-Cooke, 1956).

Anatomically, 3 groups are distinguished among the Oleoideae. In the ray type and the ring-porous condition *Fraxinus* strongly suggests the *Syringa-Ligustrum* group. In parenchyma and vessel distribution in the summer wood, it resembles the *Olea-Forstetiera* group. *Fraxinus* forms a distinct group by itself as in its spring wood there occurs very large thin-walled vessel segments with their transverse, porous end-walls. In rays and vessel structure, *Forsythia* (Syringae-Oleoideae) approaches *Jasminum* (Jasminoideae) more closely than to any other genera of Oleoideae. Moreover, it differs from *Syringa* in type of parenchyma distribution, and has much longer uniseriate extensions on the multiseriate rays (Sax & Abbe, 1932).

Cytology

Cytological studies of Sax & Abbe (1932) indicate that the somatic chromosomes of *Jasminum* are somewhat longer than those of the members of sub-family Oleoideae. The chromosome number and morphology in this genus seem to support its taxonomic grouping in a second sub-family (Jasminoideae). Also chromosome
number in *Forsythia* (14) is very close to that of *Jasminum* (13) and it is different from that of all the other genera of Oleoideae. The basic number in the family is probably 12.

According to Taylor (1945), there are 2 distinct cytological groups in the family. The 11-, 13- and 14- chromosome types (*Menodora, Jasminum, Forsythia, Fontanesia* and *Abelionphylldum*) have more in common among themselves than they have with the members of the 23-chromosome group (*Olea, Ligustrum, Fraxinus* and *Syringa*). The whole 23-chromosome group, in his opinion, has probably originated as the result of hybridisation of 11- and 12- chromosome prototypes, which are not known to day.

Krishnaswamy & Raman (1948) have reported 13 haploid chromosomes in *Jasminum flexile* Vahl studied here.

**Grafting**

Sax & Abbe (1932) state that grafting compatibility between *Syringa* and *Fraxinus* indicates a rather close relationship between these genera. Chester (1931) found complete incompatibility of grafts between *Syringa* and *Forsythia*. These differences indicate a remote relationship between them (Taylor, 1945). According to De Candolle (1844) *Syringa* can also be grafted on *Fraxinus, Chionanthus* and *Fontanesia;* the *olive* can be grafted on *Phillyrea* and *Fraxinus.* By its grafting relationships *Fraxinus* shows affinity with *Syringa-Ligustrum* group on one hand and the *Olea-Forestiera* group on the other hand (Sax & Abbe, 1932).
Alexant (1922) has stated that the Oleaceae gives starch positive reaction with Apocynaceae and with other Contortae. Hoffgen (as cited in Andersson, 1931) had used serum diagnosis for Balouya auricula (Celastraceae). The experiment was not in agreement with Oleaceae. As against this, he found that the Apocynaceae was giving a negative reaction. Chester (1931) working with Chionanthus, Fraxinus, Forsythia, Liguistrum and Syringa found no normal precipitin reactions between these genera.

Floral biology

Bhatnagar (1956, 1957a) studied floral biology of Jasminum sambac and J. multiflorum from the view points of blooming period and its duration, average diameter and weight of the flower, sepals and petals etc. Contribution to the biology of flowering in Fraxinus has been made by Valoova (1933a). Vigodski de Philippi (1937, 1938), Morettini (1939, 1940) and Morettini & Bagnoli (1949) recorded some observations on Olea.

Sterility of ovules

Sterility of ovules created interest to study its causes. Billings (1901) even denied fertilisation in Syringa dubia and Forsythia. The degeneration generally takes place at the archesporial stage in the olive (Petri, 1920). The percentage of abortion is exceedingly high in those plants of the same
variety where the fruit matures late (Favilli, 1947). Favilli also found that in 2 varieties of olive the percentage of aborting ovules was fairly high in autogamy than in cross pollination while in the third variety, reverse was the case. Campbell (1910, 1912a), Pirotta & De Pergola (1913b), Morettini & Valleggi (1940), Bottari & P. Spina (1950) and Bottari (1955) have shown auto- sterility in many varieties of olive. Autogamy occurs only in a few varieties.

Pirotta (1919) reported olive individuals exclusively with male flowers. Petri (1920) categorically reported that there are no olives where flowers are solely stameniferous; both hermaphrodite and male flowers exist together. Visser (1956) challenged Moewus (1950), who maintained that spraying of boric acid would induce fruit setting in autosterile Forsythia intermedia.

Embryology

(a) Microsporangium: Andersson (1931) observed a plate of archesporial cells in each lobe of the developing anther of Ligustrum ibota. The number of middle layers is 1 or 2. The secretory tapetal cells become multinucleate (Juel, 1900; Andersson, 1931; Messeri, 1950b). The tapetal cells of Phillyrea angustifolia simulate even the embryo sacs (Andersson, 1931). Messeri (1950a) found the tapetum to be of sporogenous origin in an abnormal carpellary anther of Olea europaea.

Moore & Behney (1908) ascertained conditions of certain
winter buds. They observed mother cell stage from October to February in the anthers of *Fraxinus americana*. Joel (1900) attributed immense pollen sterility in *Syringa* to nuclear lobings, irregularly dispersed chromosomes, abnormal spindles and cytomixis during meiosis I. Valcoa (1953b) made some observations on the spermatogenesis of the ash, while Battaglia & Brerriglieri (1955) studied regular and irregular microsporogenesis in *Olea europaea*. The reduction divisions are simultaneous in *Syringa* (Juel, 1900; Borgenstam, 1932; Schnarf, 1931), *Foraythia, Fraxinus, Phillyrea* (Andersson, 1931), *Jasminum* (Taylor, 1945) and *Olea* (Messeri, 1950b).

In *Foraythia suspense* (Andersson, 1931), the same anther loculus showed widely separated stages of division and development of the pollen. Rarely, 4 cells of the tetrad failed to separate in *Syringa vulgaris* (Andersson, 1931).

The mature pollen grains of *Olea* have 3 or 4 colpi or furrows. Sexine part of the exine is generally thicker than the nexine (Erdtman, 1952). Wodehouse (1935) related anemophily with the reduction of the surface sculpture. Andersson (1931) observed sperm nuclei in the pollen tube of *Foraythia*. Johnston (1941) dealt with the cytological study of male gamete formation in *Foraythia*, in which the division of the generative cell takes place in the pollen tube. The division is characterised by a distinct metaphase plate. The pollen is shed at the 2-celled stage (Schnarf, 1931).
Instances of carpellary tissue forming anther lobes were observed in *Syringa* (Andersson, 1931). In *Olea* (Messeri, 1950a), the sexual inversion is only the differentiative phase of the male sex cells but not an organ formative stage of an anther. The abnormal pollen chamber had a multinucleate tapetum but no middle layers and the endothecium.

(b) **Ovary:** Generally the ovary of Oleaceae is bicarpellary and bilocular. Joshi (1942), however, found that the rudimentary ovary in the male flowers of *Osmanthus suavis* is unilocular unlike that of the bisexual flowers. Moreover, the ovary opens out into 2 leaf-like carpels with free margins, thus clearly indicating its bicarpellary nature.

The number of ovules in each loculus is generally 1 or 2 but rarely 4, 8 or more. In species of subgenus *Humenodora*, 4 ovules in each loculus are attached about halfway up the placenta (Taylor, 1945). In *Jasminum simplicifolium*, the ovules are attached on the entire septum but in *Ligustrum*, they arise at a higher level (Andersson, 1931). The ovules are generally anatropous (epi- or apotropous) in Oleaceae (Agardh, 1853; Andersson, 1931). However, Knoblauch (1897) and Andersson (1931) reported amphitropous ovules in *Jasminum* and *Forsythia* respectively. Hemitropous ovules are found in *Chionanthus* and *Motylea* (Andersson, 1931). *Myzoporum* has probably orthotropous ovules (Taylor, 1945).

Heterostyly has been reported in *Forsythia* (Andersson, 1931)
and Jasminum (Pirotta, 1835*). The stylar canal is lined by glandular cells in Olea (King, 1933). The epidermis of the funiculus and the ovarian septum consists of richly cytoplasmic cells in Syringa. In Olea and Ligustrum, such cells form a transmitting tissue in the ovarian chamber (Andersson, 1931).

(c) Megasporangium: The archesporium in the young ovule consists of a single cell in Fontanesia, occasionally 2 cells lying side by side in Fraxinus and Syringa or lying one over the other in Forsythia and Chionanthus (Andersson, 1931) and 6 or more cells in Jasminum nudiflorum (Jönsson, 1881).

The ovule is tenuinucellar and unitegmic. A parietal cell is never cut off (Schnarf, 1931). However, Billings (1901) showed 2 parietal layers in Fraxinus excelsior and periclinal divisions in the nucellar epidermis of Forsythia. Andersson (1931) reported similar divisions in Forsythia viridissima and Fraxinus excelsior.

1 or 2 nucellar layers occur below the epidermis on the sides of the megaspore mother cell or the tetrad (Andersson, 1931; King, 1933; Messeri, 1950b). In Syringa vulgaris (Warming, 1878) and Fraxinus (Billings, 1901), 4 or more cell layers occur on the sides of the megaspore mother cell.

The nucellus is used up during the dyad stage to 4-nucleate embryo sac stage. Its place is taken by 'plasma rich'

* As cited in Church (1908).
cells of doubtful origin in *Olea* (King, 1938). Jönsson's (1881) account of persistent nucellus in *Jasminum* is refuted by Andersson (1931). The nucellar epidermis ruptures at various stages of development of the female gametophyte and only the chalazal part of the nucellus is left over embracing the embryo sac. Tischler (1903) reported a similar situation in *Syringa vulgaris*.

In *Fraxinus*, the integument grows higher up on the side away from the funiculus and extends the micropylar canal. The cells of the single massive integument contain abundant starch in *Jasminum nudiflorum* (Andersson, 1931).

The integumentary tapetum forms a partial or a complete envelope. The tapetal cells are stretched in a radial direction and become rich in plasma (Andersson, 1931). The cells are frequently half-absorbed at the micropylar end (Messeri, 1950b). They may divide periclinally in *Syringa*. The tapetum is not at all organised in *Jasminum nudiflorum* (Andersson, 1931).

The vascular bundle entering the ovule sometimes branches in the chalaza in *Fraxinus* and *Ligustrum* (Andersson, 1931). In *Jasminum* (Joshi & Fotidar, 1940) and *Nyctanthes* (Fotidar, 1942), it even divides into 2, soon after its entrance into the funiculus. The vascular strands extend far up into the tip of the integument in *Jasminum* and *Syringa* (Andersson, 1931). According to Billings (1901), the vascular bundle of *Fraxinus excelsior* passes through the funiculus and it nearly runs around the whole ovule. Copeland (1960) has doubted the validity of these observations.
She hypostase consists of lignified cells in *Jasminum simplificifolium* (Andersson, 1931) or darkly stained cells in *Fraxinus excelsior* (Billings, 1901).

(d) **Megasporogenesis and female gametophyte:** The megaspore tetrads may be linear or T-shaped. Andersson (1931) observed an instance of 5 megaspores in a tetrad in *Syringa vulgaris*. The chalazal megaspore is the functional spore.

In *Jasminum simplificifolium* and *J. nudiflorum*, as many as 4 and 7 embryo sacs were observed to develop from the same ovule respectively. It was difficult to locate their exact origin as several archesporial cells were functional (Andersson, 1931).

The development of the embryo sac conforms to the Polygonum type. Bisporic *Allium* type is reported in *Olea europaea* and *O. chrysophylla* (Andersson, 1931). King (1933) and Messeri (1950b) have confirmed bisporic development in *O. europaea*. Bercovich (1939)* observed the same for *Phillyrea*. On the other hand, Armenise (1957) reported 6-nucleate embryo sac in *E. latifolia*.

The binucleate embryo sac in *Olea europaea* encroaches upon the nucellar cells and makes its way into the micropylar canal (Pirotta & De Pergola, 1913a; Messeri, 1950b). Andersson (1931) reported that the embryo sac grows beyond the tapetum in *Olea europaea*. In one case, it also extended deep in the chalaza in *Jasminum*.

* As cited in Messeri (1950b).
The mature embryo sac is curved in *Syringa*, elongate or oval in *Olea*, irregular in *Jasminum* (Andersson, 1931) and extremely long and narrow in *Forsythia* (Billings, 1901).

The synergids are pointed in *Olea europaea* (Messeri, 1950b) and *Chionanthus virginica* but hooked in *Forsythia suspensa* and *Jasminum simplicifolium* (Andersson, 1931). Guignard's (1882) observation that the egg is lateral in *J. grandiflorum* was confirmed by Andersson (1931) for the most of the Oleaceae. The polar nuclei either remain in the chalazal half of the embryo sac (Andersson, 1931) or little below the middle part (King, 1938; Messeri, 1950b) or just below the egg (Billings, 1901; Andersson, 1931). In *Chionanthus virginica*, 2 antipodal cells become hypertrophied while the nucleus of the third one lies above them (Andersson, 1931). Messeri (1950b) failed to observe the antipodals in *Olea europaea* but King (1938) noted their early degeneration. Guignard (1882) has shown 3 antipodal nuclei in the embryo sac of *Jasminum grandiflorum*. There are only 2 antipodal nuclei in *Phillyrea latifolia* (Armenise, 1957).

(e) Endosperm: It is cellular in *Syringa vulgaris* (Stölt, 1921), *S. josikaea* (Dahlgren, 1923), *Jasminum hederaceum* (Andersson, 1931), *Olea europaea* (Messeri, 1950b) and *Fraxinus velutina* (Copeland, 1960). Probably it is of the same type in *Frasinus excelsior* (Billings, 1901; Andersson, 1931), *Fontanesia phillyreoides*, *Forsythia viridissima*, *Ligustrum ibota*, *L. amurense*, *L. pratti* and *Chionanthus virginica* (Andersson, 1931). The account of Church (1908) on *Jasminum nudiflorum* and *J. officinale* is not critical.
Andersson (1931) described a peg-like extension at the micropylar region of *Fraxinus excelsior* as a reduced haustorium. In *Jasminum beesianum*, 2 endosperm cells are markedly unequal. In *Olea capensis* (Andersson, 1931) and *O. europaea* (Messeri, 1950b), the chalazal and the micropylar endosperm cells exhibit dimorphism. Netolitzky (1926) mentioned sinuses and ruminations on the endosperm surface. At maturity, the endosperm cells surrounding the zygote of *Olea europaea* degenerate and stain darkly (Messeri, 1950b).

(f) **Embryo**: The embryogeny of Oleaceae is in a confused state. Johansen (1950) categorically remarked that it is not yet definitely determined whether the terminal cell divides transversely or longitudinally. On the basis of Andersson's (1931) work, he classified the embryo development in *Fraxinus*, *Syringea* and *Ligustrum* as of the Alyssum variation of the Onagrad type. The embryo of *L. ovalifolium* follows development as Physalis III variation of the Solanad type (Souèges, 1942).

The zygote becomes thread-like or tubular in *Fraxinus*, *Jasminum*, *Ligustrum* (Andersson, 1931) and *Olea* (Messeri, 1950b). King (1938) depicted zygotic outgrowth in *O. europaea*. In *Ligustrum ovalifolium*, a wedge-shaped upper cell functions as an epiphysis initial (Souèges, 1942). Steinbauer (1943) has shown possibility of extra embryos in *Fraxinus*.

(g) **Parthenocarpy**: Parthenocarpy was suspected in *Olea europaea* (1912b) and reported in *Phillyrea media* (1915) by Campbell. Andersson (1931) confirmed this observation in *Olea europaea*. He assigned the parthenocarpy of *O. europaea*
to Class II of Tischler (1913). Favilli (1945, 1947) observed variations from year to year and race to race in the development of parthenocarpic olives. Messeri (1947) noted the drupes with the degenerated gametophytes and without any traces of the zygote and the endosperm. Campbell (1912b) noticed that the unfertilised ovary developed into a rounded drupe while the fertilised ovary formed an elliptical one.

(h) Fruit: The fruit of Menodora and Jasminum consists of 2 divaricate cocci but in Jasminum, it is fleshy and indehiscent. The fruit is schizocarpic in Nyctanthes, capsular in Forsythia and Schrebera, drupaceous in Olea and Linociera, bucate or drupaceous in Ligustrum and 1-seeded winged achene in Fraxinus. In spite of identical ovarian structure, the fruits are of diverse morphological nature in Oleaceae.

(i) Pericarp and Seed coat: The pericarp of Olea europaea is generally differentiated into 3 zones. Ruby (1917) represented the mesocarp as consisting of large but very compact parenchyma cells. The cells of the mature mesocarp below the epidermis are smaller and thick-walled. King (1938) did not find such distinction in the mesocarp cells. According to him the endocarp consists of thick-walled isodiametric as well as elongate stone cells. The stone cells extend like a palisade tissue in the lower one-third part of the capsular fruit of Syringa bretschnedleri (Andersson, 1931). In Jasminum officinale, the ovary wall is membranous, transparent undifferentiated (Church, 1908).
The outer epidermal cells of the testa are lined internally with cork in *Fraxinus*, *Ligustrum* and *Phillyrea*. It is meagre in *Olea* (Netolitzky, 1926). The large columnar and succulent cells of the testa act as a water reservoir in *Jasminum nudiflorum* and *J. officinale* (Church, 1903). In *Menodora* (Taylor, 1945), the outer part of the testa consists of huge transparent cells. They contain starch in *Nyctanthes* (Knoblauch, 1897) and chlorophyll in *Olea* (Pirotta, 1884).