

K. LAKSHMINARAYANA* & H. M. DEVI*: **Embryology**
of *Linociera intermedia* Wt. (Oleaceae)

K. ラクシュミナラヤナ*・H.M. デビ*: *Linociera intermedia* Wt.
(モクセイ科)の胚発生

The Oleaceae is a small family of the flowering plants represented by 29 genera and 600 species (Willis 1966). Economically the family is very important because it provides many valuable ornamentals which are of much garden value. Though this family had attracted the attention of early embryologists, the embryological work in this family is very meagre and cover only a few members. Therefore it is felt that the family deserves further attention embryologically. In the present investigation the various aspects of the life history of *Linociera intermedia* starting from flower bud to fruit were investigated.

Material and methods The material *Linociera intermedia* Wt. was collected from the famous holy hills of Tirumala [Andhra Pradesh] by Prof. G. Rajeswara Rao was fixed in formalin acetic-alcohol. Dehydration and infiltration were followed according with the customary methods. The sections were cut between 5-12 μm in thickness and stained in Delafield's hematoxylin.

Observations *Linociera intermedia* Wt. is a large tree with dense axillary panicles. The flower is tetramerous and consists of small, four lobed calyx, four short petals which are valvate in bud. The stamens are typically two in number, epipetalous and consist of short filament and broad connective. Ovary is 2-celled with two ovules in each cell. Fruit is an ellipsoid drupe with thin exocarp and bony endocarp.

Microsporangium, microsporogenesis and male gametophyte. The primary archesporium becomes differentiated in the four corners of the anther. The archesporial cells divide periclinaly and an inner primary sporogenous and an outer primary parietal layers are formed. The latter by further periclinal divisions give rise to an anther wall which is 3-layered (Fig. 1. A). The inner most parietal layer develops as the anther tapetum. The subepidermal layer develops fibrous thickenings and forms the fibrous endothecium which is uni-

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seriate (Fig. 1C). However, these fibrous thickenings extend to some of the connective cells and there the fibrous endothecium becomes multilayered. The ephemeral middle layers become degenerated during the further growth of the anther. The tapetum is parietal in origin and is of the secretory type. The tapetal nuclei divide mitotically (Fig. 1. B) and produce 4-6 nucleate tapetal cells (Fig. 1. A).

The primary sporogenous cells undergo few mitotic divisions resulting in a moderately extensive sporogenous tissue (Fig. 1. A). The pollen mother cells undergo simultaneous divisions and produce isobilateral and tetrahedral tetrads of which the latter being more common (Fig. 1. D). Cytokinesis is by furrowing. The meiotic divisions in all the locules of the same anther are not synchronous. In the same anther one locule shows undivided pollen mother cells and the remaining locules show pollen tetrads. In some cases, pollen tetrads and pollen grains are seen in the different locules of the same anther.

The nucleus of the one nucleate pollen grain (Fig. 1. E) becomes displaced to the peripheral region by the formation of a large central vacuole. It undergoes mitotic division (Fig. 1. F) and cuts off a small lenticular generative cell and a large vegetative cell. The pollen grain are shed at the 2-celled stage. The pollen grains are triporate and occasionally tetraporate. The exine shows rod like thickenings and the intine is smooth (Fig. 1. E, F). The dehiscence of the anther is longitudinal and the pollen grains escape through the slit formed in the anther (Fig. 1. G).

In *Linociera intermedia* an interesting case of an abnormal anther inside the normal anther is observed (Fig. 1. I, J). This abnormal anther is seen in one of the anther locules of the normal anther. It protrudes into the adjacent locule of the normal anther by piercing through the connective (Fig. 1. I). This abnormal anther does not show the usual wall layers like epidermis, fibrous endotheclum, etc. However it shows an extensive tissue towards outside which is irregular in shape and outline. This inner anther consists of an inner layer of tangentially elongated cells which form a circular ring around the pollen grains (Fig. 1. J). This layer superficially appears as the 'anther tapetum' with cells containing a single nucleus and dense cytoplasm. The abnormal anther had two sporangia. In one of them the pollen grains are agglutinated and form a mass and in the other normal pollen grains are present. The pollen grains of the abnormal anther are identical to the pollen grains of the normal anther

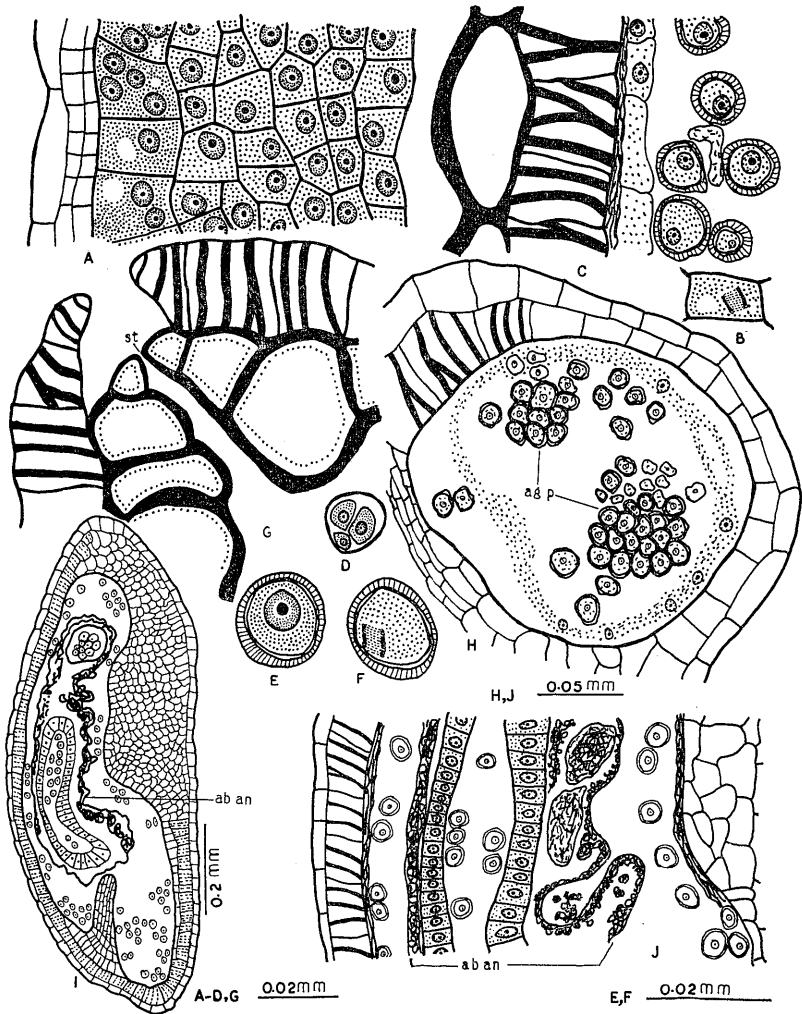


Fig. 1. A. Longitudinal section of anther showing sporogenous cells, tapetum (1-4-nucleate) and wall layers. B. Tapetal cell with dividing nucleus. C. Transverse section of part of anther showing fibrous endothecium, degenerating tapetum and pollen grains. D. Tetrahedral pollen tetrad. E. One nucleate pollen grain. F. Nuclear division in the pollen grain. G. Transverse section of anther showing dehiscing point (st, stomium). H. Transverse section of anther-sporangium enlarged to show agglutinated pollen grains (ag p). I. Longitudinal section of anther showing an abnormal anther (ab an) inside the normal anther. J. Portion of the I, I enlarged to show the details.

in all respects such as the structure of exine, intine, etc. The normal anther containing this abnormal anther shows all the usual components namely epidermis, fibrous endothecium, pollen grains and connective tissue.

Pollen and pollen sac degenerations. Degenerations of pollen at various stages of development were observed. 1, 2, 3 or all the pollen grains of a tetrad degenerate quite frequently. In most of the cases one or more pollen sacs of one or both anthers degenerate. In still others, all the pollen sacs of both the anthers are seen degenerating. In a few cases the pollen grains become agglutinated and form large masses. Quite interestingly the anthers where the agglutinated condition of the pollen is present, the subepidermal layer does not develop fibrous thickenings (Fig. 1. H). But the fibrous endothecium is differentiated on the connective side.

Megasporangium, megasporogenesis and female gametophyte. The ovary is superior, bicarpellary, syncarpous and bilocular with two ovules in each locule on axile placentation. The ovule is orthotropus, unitegmatic and tenuinucellate (Fig. 2, A). An integumentary tapetum is differentiated which is uniseriate with uninucleate cells (Fig. 2. D). The hypodermal archesporium is unicelled and it directly functions as megaspore mother cell without cutting off a parietal cell (Fig. 2. B). The megaspore mother cell gives rise to a linear tetrad of megaspores (Fig. 2. D) after the meiotic divisions (Fig. 2. C). The chalazal one is functional and develops into an 8-nucleate embryo sac of the *Polygonum* type (Fig. 2. E, F). The mature megagametophyte is spindle-shaped (Fig. 2. F). The two synergids are flask-shaped. Two polars meet at the centre and fuse before the fertilisation. The antipodals are uninucleate and ephemeral.

Fertilisation. It is porogamous. Syngamy and triple fusion occur more or less simultaneously.

Endosperm. The endosperm is *ab initio* Nuclear and in latter stages shows rumination. Cell wall formation commences from the micropylar end and extends towards the chalazal end and ultimately filling the entire embryo sac with the cellular tissue. The rumination starts even when the endosperm is in a nuclear condition and by the time a globular embryo is formed the rumination becomes completed. The rumination here is due to the irregular ingrowth of the inner lining layer of the seed coat (Fig. 2. H). The endosperm extends into the grooves (Fig. 2. G). The endosperm cells are uninucleate and possess scanty cytoplasm.

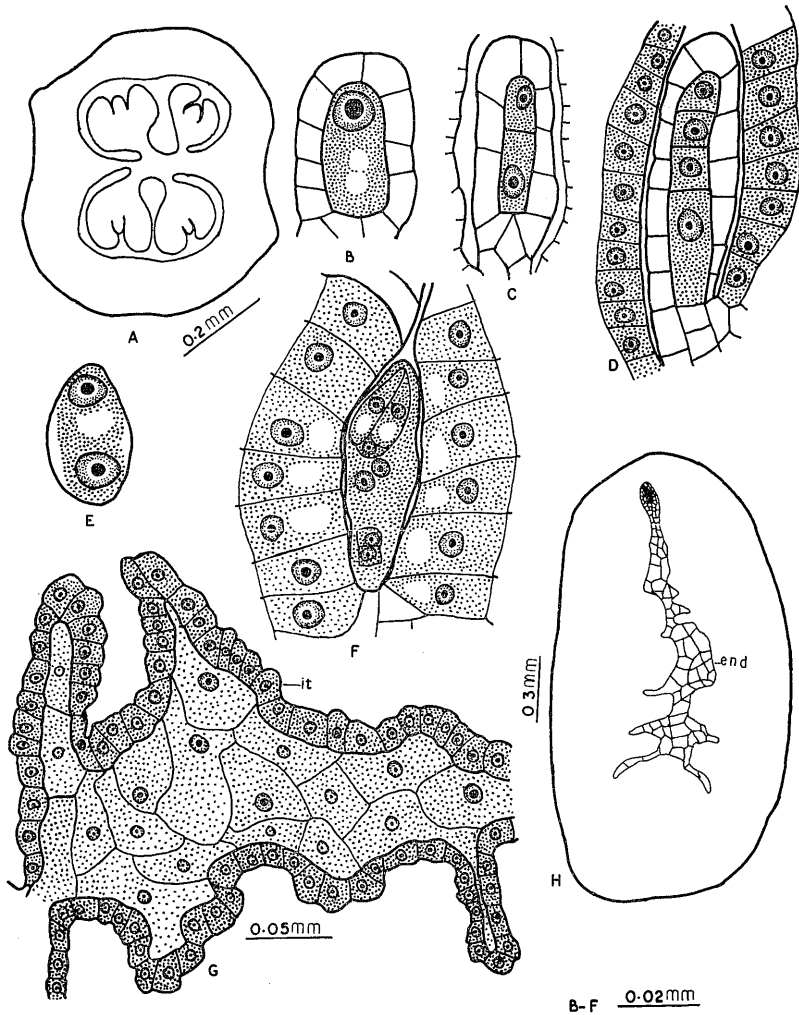


Fig. 2. *Linociera intermedia* Wt. A. Transverse section of ovary. B. Megaspore mother cell. C. Megaspore dyad. D. Megaspore tetrad. Note the integumentary tapetum. E. 2-nucleate embryo sac. F. Mature embryo sac surrounded by the integumentary tapetum. G. A portion of the ruminant endosperm enlarged. H. Longitudinal section of massive seed coat, ruminant endosperm (end) and embryo.

Embryo. The embryo development could not be traced in detail due to the paucity of the material. However only a few stages of embryo development could be traced (Fig. 3. A-C). By a comparison of the available embryogenic stages with the stages obtained by the previous workers (Souéges 1942, Maheswari Devi 1958, 1975) it appears that the embryogeny in this species is also of the Solanad type. The suspensor is uniseriate and elongated.

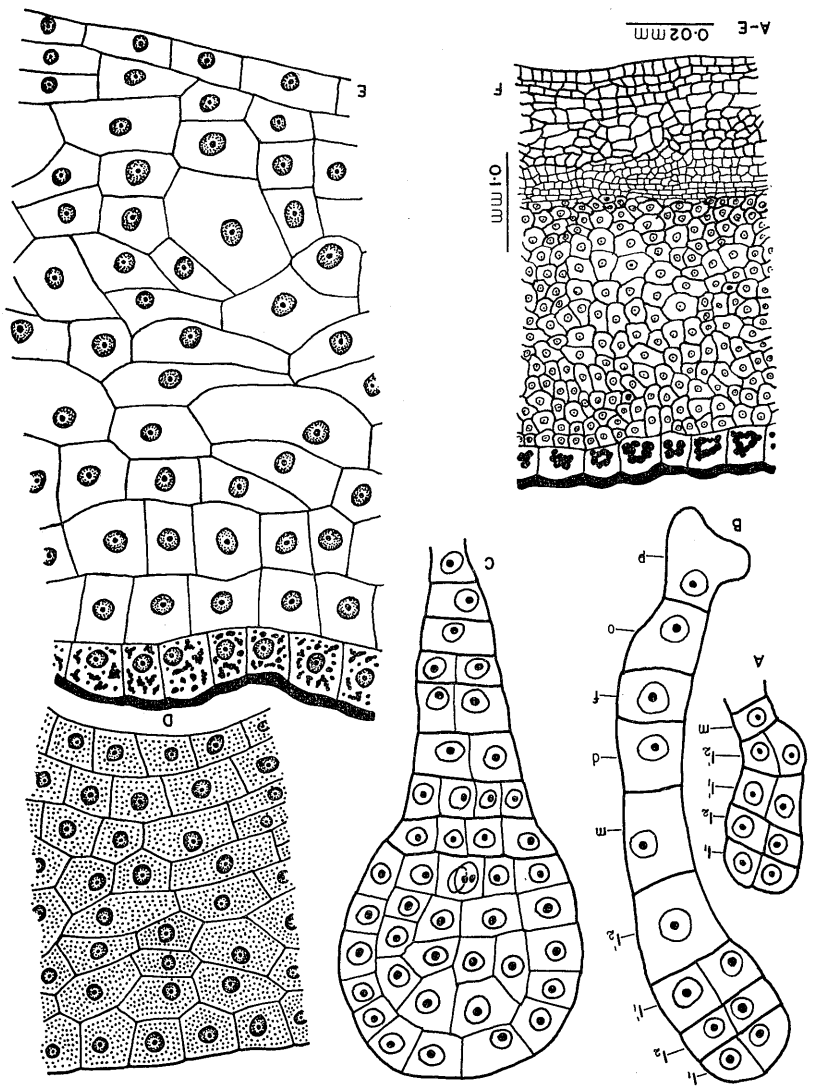
Seed coat and fruit wall. The integumentary primordium arises simultaneously with the differentiation of the megaspore mother cell. It grows soon and covers the nucellus by the time the megaspore mother cell enters into the meiotic divisions. An integumentary tapetum makes its appearance by the time a megaspore dyad is formed in the ovule. It can be clearly seen at the megaspore tetrad stage. The integument is multiplicative and becomes massive at the post fertilisation stages. At the cellular endosperm stage the seed coat is very irregular in its inner side.

The ovary wall at the megaspore mother cell stage consists of 8-10 layers of parenchymatous cells which possess prominent nuclei and less cytoplasm (Fig. 3. D). At mature embryo sac stage, it consists of 14-16 layers of parenchymatous cells. All the cells are similar in appearance and have prominent nuclei but no cytoplasm (Fig. 3. E). The epidermal cells at this stage begin to accumulate tannins. The outer wall of the epidermis becomes thickened. After fertilisation, it grows extensively and becomes massive. At a few celled embryo stage the fruit wall is 25-30 layered thick and at this stage it can be demarcated into two distinct zones, the exocarp and the endocarp. The exocarp consists of 13-16 layers of somewhat large, loosely arranged, irregular cells. The endocarp consists of small, angular and closely arranged cells. By this stage the outer epidermal cells accumulate larger quantities of tannin. The outer wall of the outer epidermis is also very much thickened (Fig. 3. F).

Discussion The anther tapetum in *Linociera intermedia* is parietal in origin and is of the secretory type. The tapetal cells though uninucleate to start with becomes 4-6-nucleate due to mitotic divisions in the tapetal nuclei. Maheswari Devi (1958, 1975) also observed 3-4-nucleate tapetal cells in *Nyctanthes arbor-tristis*. Kapil & Vani (1966) reported nuclear divisions and fusions and ultimate formation of large irregular polyploid nuclei in the tapetal cells in *N. arbor-tristis*.

The presence of an abnormal anther inside the normal anther is reported in

Fig. 3. *Linociera intermedia* Wt. A-C. Embryogeny. D-F. Fruit wall.



L. intermedia. In having pollen grains etc. the abnormal anther exactly resembles its normal counterpart. Such a condition is not reported in any other member of the family so far investigated. However, Andersson (1931) in *Syringa bretschnideri*, Messeri (1950) in *Olea europea* recorded development of pollen sacs from the ovules, while Dutt (1950) in *Jasminum grandiflorum* and Patel (1965) in *N. arbor-tristis* and *J. flexile* reported carpelloid stamens. Thus in this family it appears that there are a few abnormalities in the development of anther and ovule.

In the presence of orthotropous ovules *L. intermedia* differs with the rest of the members of the Oleaceae so far investigated. Uniseriate integumentary tapetum with uninucleate cells as reported in the present investigation was reported by Maheswari Devi (1958) in the species of *Jasminum* and *Noronhia emarginata*. She also reported biseriate integumentary tapetum at places in *Ligustrum confusum* and *N. arbor-tristis*. In the present study for the first time ruminant endosperm is recorded in the family Oleaceae. In *L. intermedia* the rumination is due to irregular inner lining layer of the seed coat.

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モクセイ科 *Linociera intermedia* Wt. の胚発生を報告する。葯の壁は繊維状の endothecium でつくられる。タペタムは分泌型である。花粉は tricorperate, まれに tetra-corpate で、葯内で2細胞期まで成長する。胚珠は直生、薄層珠皮は1枚。珠心内部は1個の胞原細胞からなり、それが直接大孢子母細胞になる。胚嚢形成は *Polygonum* 型である。胚乳形成は Nuclear 型で、成熟すると種皮内面の不規則な成長によって胚乳表面に rumination がつくられる。胚形成の様式は Souéges (1942) や Maheswari Devi (1958, 1975) が他のモクセイ科の種で報告したものと同じである。

□ Jefferson, R. M. & K. K. Wain: **The nomenclature of cultivated Japanese flowering cherries (*Prunus*): The Sato-zakura group.** U. S. Department of Agriculture, National Arboretum Contribution No. 5, 44 pp. 1984. 日本のサトザクラ類の園芸品種の名称をできるだけ整理統一しようとして作られたリストである。野生種との関係が不明な雑種起源のものもふくまれているので、学名の下にはなく、全部を 'The Sato-zakura group' の総称の下に扱って、品種名のアルファベット順に配列し、同意語は相互に引きだせるようにいれてある。正しい品種名として採用した名の下に、その文献が引用してある。例えば 'FUGENZO' の項には、水野元勝 (1681) に初まり、*Prunus serrulata* var. *veitchiana* Bean (1914) まで多くの文献が引用されている。終りに引用されなかった園芸品種名のリストと文献のリストがある。日本から見ると不十分な点や落ちていた名も多く、植物学的には物足りない点もある。例えば、'NADEN' もふくまれているが、*Prunus sieboldii* Wittm. や *P. koidzumii* Makino などの名はでてこない。しかし日本のサクラの園芸品種に興味のある人には便利なリストである。定価は明記してないが、National Technical Information Service, 5285, Port Royal Road, Springfield, Virginia, 22161, U. S. A. で購入できる。(原 寛)

□ 国立科学博物館: **国立科学博物館蔵書目録和文編1984年版** 684 pp. 1984. 同館発行・非売品。科学博物館の図書はカードやリストが不備で文献の探索に不便であったが、このたび同館図書課の努力で和文文献の目録が作成された。植物学の部には48頁1394件がリストされている。図書館的センスの分類のため、たとえば、中井: 朝鮮森林植物編, その他農林・園芸関係とされた多くの文献は植物学でなく、産業の部に収容されていたりするので、利用には注意を要する。同館の雑誌については逐次刊行物目録が1979年に刊行されており、残るは欧文編のみとなったが、これも現在進行中である。非売品であるが、主な大学図書館、博物館には配布される。(金井弘夫)