

## Morphological Studies on the Development of *Aquilaria agallocha* Roxb. Seeds

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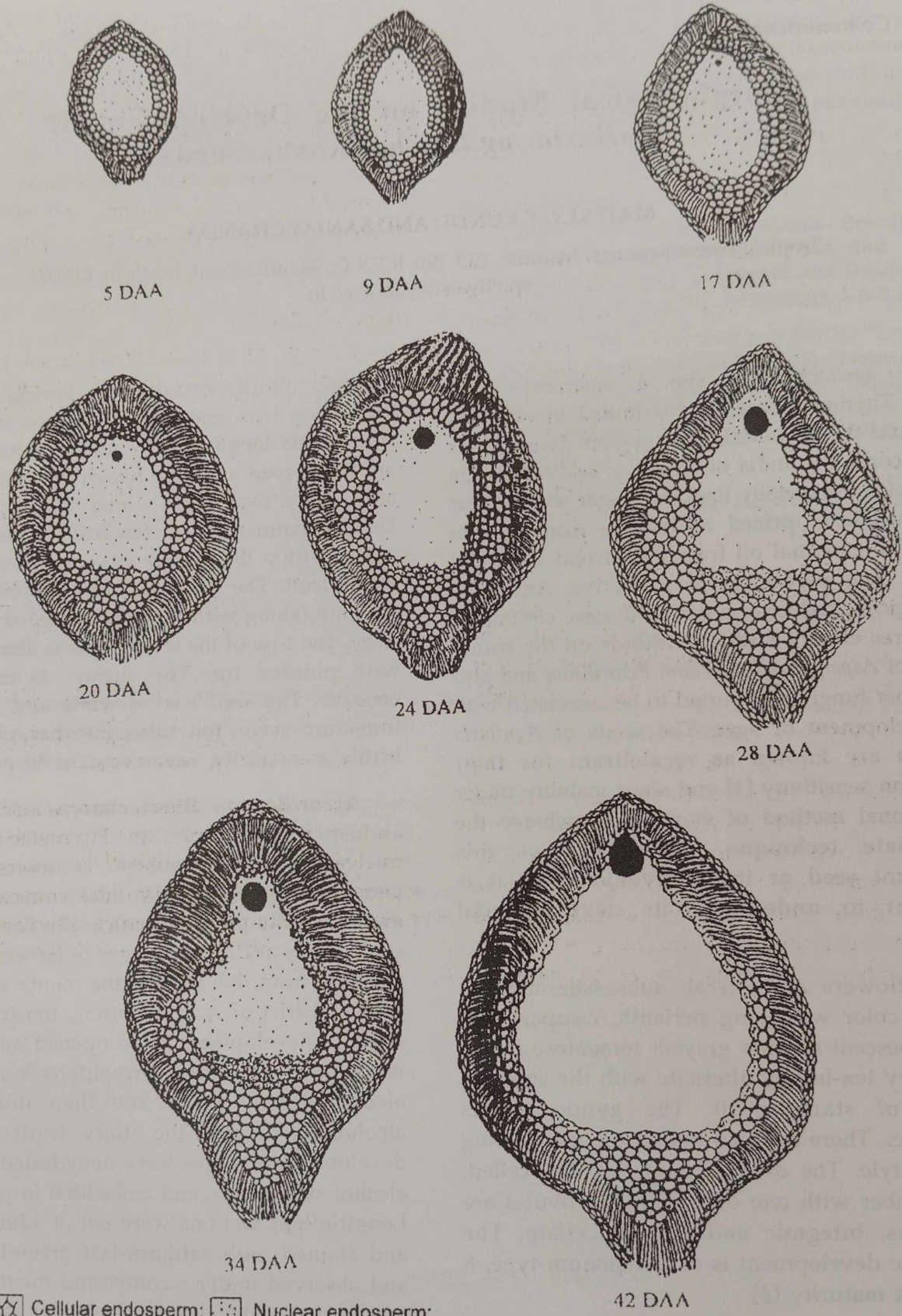
*Aquilaria agallocha* Roxb. syn. *A. malaccensis* Lam. (family Thymelaeaceae) is distributed in southern China and the Indo-Malaysian region. Two species were recorded in India of which *A. agallocha* is the source of commercially important agar wood. Agar wood has been prized as incense from ancient times. The essential oil from agar-wood is valued in high class perfumery as a fixative. Agar is a pathological product of a fungal disease contracted by the tree chiefly through wounds on the trunk. Species of *Aspergillus*, *Fusarium*, *Penicillium* and also some other fungi are reported to be associated with the development of agar. The seeds of *Aquilaria agallocha* are known as recalcitrant for their desiccation sensitivity [1] and short viability under conventional method of storage. To achieve the appropriate technique for storage of this recalcitrant seed or its embryonic parts, it is important to understand its developmental anatomy.

The flowers are lateral, subsessile umbels, white in color with long perianth, campanulate, lobes pubescent outside grayish tomentose inside [2]; nectary ten-leafed, alternate with the stamina; number of stamens 10. The gynoecium is syncarpous. There are two united carpels bearing a single style. The ovary is superior, two-celled, each chamber with one ovule [3]. The ovules are anatropous, bitegmic and crassinucellate. The embryo-sac development is of polygonum type, 8 nucleate at maturity [4].

The fruits are capsule, which are short, broad and woody. It is compressed, loculicidally two-

valved, ovoid, usually measuring 2.5-3 cm, containing two seeds, rarely one. At maturity the fruit opens longitudinally into two halves. Fruits are with broad and long densely villous. The seeds are solitary, ovoid with a long tail like appendage. During maturity when the fruit opens, the seeds swing with a thread-like structure to the pericarp of the fruit. The seed measures approximately 1.6 cm long (along with the appendage) at the mature stage. The base of the seed proper is almost rounded with pointed tip. The surface is smooth and concave. The seed coat is white and soft during immature stage, but turns into hard, brown and brittle at maturity. Seeds contain 40 per cent oil.

According to Bhattacharya and Johri [4], endosperm formation in Thymelaeaceae is of nuclear type. The embryo is inverse, without perisperm. It is large with thick convex cotyledons and upwardly pointing radicle [3]. For the present study, fruits at different stages of development were collected from five trees in the month of June from Jorhat district of Assam (India). Ten fruits of each stage of development were opened and the seeds were fixed in FAA (formaldehyde-acetic acid-alcohol) for 12 hours and then stored in 70% alcohol [5]. During the study, fruits of different developmental stages were dehydrated in an ethyl alcohol-xylol series, and embedded in paraffin wax. Longitudinal sections were cut at 12mm, mounted and stained with safranin-fast green-hematoxylin and observed under a compound microscope (15x) followed through drawings. At the early stage of maturation (approximately five days after anthesis (DAA) the seeds were pale yellowish in colour



- Embryo;
  Cellular endosperm;
  Nuclear endosperm;
- Inner parenchymatous layer;
  Outer thick walled layer;
- Palisade layer;
  Cotyledon.

Fig. 1. Development stages of *Aquilaria agallocha* seed

and very soft. The longitudinal section of the seed showed the embryo sac, which remained filled with a liquid tissue mass corresponding to the nuclear endosperm surrounded by three layers of integument. No embryo development is visible at this stage. The initiation of the embryo takes place at the pointed apex of the ovule, the micropylar end (at approx. fifteen DAA). At the initial stage it is very small, almost globular in shape. The development of the embryo is associated with the cellularization of endosperm lining the wall of the embryo sac. The endosperm nuclei at the chalazal part of the embryo-sac was observed to be larger than those in the micropylar part. This may be due to an actual growth in their size as observed in *Colutea*, *Ranunculus* and some members of the *Cistaceae* or due to fusion of adjacent nuclei as in *Primula*, *Tilia*, *Malus* and some members of the *Compositae* [6]. Like *Asclepias*, *Calotropis* and *Crepis* the wall formation in the free nuclei takes place at very early stage [6]. It was observed that the cells of endosperm are usually isodiametric and store large quantities of food materials. The single palisade layer of the integument was differentiated into two layers (at approx. 20 DAA).

As the development proceeds, the nutrients of the endosperm is being absorbed by the growing embryo; leaving only a thin papery layer. Simultaneously the cotyledons develop into a heart-shaped and convex structure. Embryos at maturity become differentiated into two cotyledons, radicle and the plumule. The embryonic axis consists of radicle and the plumule, which remains hidden between the two cotyledons. The embryonic axis

lies parallel to the longitudinal axis of the nucellus. At the fully mature phase the seed coat consists of an outer layer of thick walled dead, sclerotic cells, an inner layer of thin walled parenchymatous cells and single palisade layer between these two layers.

The present preliminary studies should be followed by detailed histological and morphological investigations on the seed development in this species.

#### REFERENCES

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