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THE DEVELOPMENT OF MEGASPORANGIUM, MEGASPOROGENSIS AND FEMALE GAMETOPHYTE, EMBRYOGENY AND CARYOPSIS IN *ARUDINELLA PUMILA* (HOCHST.EX.A. RICH)

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ABSTRACT:
The paper deals with embryological investigation of *Arundinella pumila.* The ovules are bitegmic, pseudocrassinucellate and camyplotropus, polygonum type embryo sac with antipodal complex. The embryo development conforms to Asterad type. Endosperm, caryopsis, seed coat and pericarp, have been described critically.

Key words: - Poaceae, Poodeae, Hypostase, Embryology, Embryo development, Caryopsis.

INTRODUCTION:

The division of the Poaceae into two subfamilies viz., Pooideae & Panicoideae as proposed by Brown (1814) is being maintained even today. Embryological features of this taxon follows the uniform pattern at subfamily level (Narayanswami 1955 a,b,c, 1956; Koul, 1997 a,b; Raju 1980; Bhanwara et al., 1991; Deshpande & Makde 1994; Nikhade & Makde, 1997). Caryopsis a unique fruit of Poaceae were pericarp free from seedcoat. The present paper pointed out the some embryological character of taxonomic value.

MATERIALS AND METHODS:

The material of *Arundinella pumila* was collected from Totaladoh localities of Nagpur (M.S.) India. The voucher specimens (N-7) submitted to the herbarium Department of Botany RTM Nagpur university Nagpur. Spikelet's at various stages of development were fixed in 70% F.A.A. Customary methods of dehydration, infiltration and embedding followed. Sections were cut 8-12µ thick & stained with Delafields hematoxylin. Erythrosin and light green stain was used as counterstain. Mature embryos were dissected out and stained with safranin.

Ovule, Megasporogenesis and female gametophyte.-

The family is characterized by bi/tricarpellary, syncarpous pistil having a single ovule in the unilocular ovary (Lawrence, 1951, Hutchinso, 1973). The ovules are campylotropous, tenuinucellate & bitegmic (Fig. 1M-N). The integuments both inner & outer are two layered for their major portion. The hypodermal female archesporium functions directly as megaspore mother cell (Fig. 1S). The megaspore mother cell undergoes meiosis I followed by successive cytokinesis. Meiosis II in the dyad cells is synchronous. Thus, megaspore tetrads are formed at this stage both the integument are well developed and these extend almost upto the shoulder at the nucellus. The chalazal megaspore alone functions & remaining three megaspore degenerate (Fig. 1Q). The degenerating remains persist up to the organsiation of mature embryo

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sac (Fig. 2C). The mature embryo sac more or less cylindrical. The egg apparatus consists of a flask shaped egg & two synergids. The two polars are quite close approximation to each other very near the egg (Fig. 2C). They fuse to form secondary nucleus just prior to fertilization (Fig. 2D). At the time of embryo sac organization there are only three antipodals cells located at chalazal end, later on mitotic division in them results in an increase in their number. Thus, antipodal complex composed of 10-12 cells (Fig. 2D).

Hypostase :

A group of nucellar cells at chalazal end of the ovule becomes conspicuous & differ from the adjoining cells termed as hypostase. The hypostase is well developed & cylindrical. Its cells get filled with tanniniferous granular deposits at the globular stage of embryo development (Fig. 2E). At advanced stage of embryo development they are completely packed with tannin (Fig. 2F).

Endosperm:

The endosperm development is free nuclear type initially. It later becomes cellular & shows deposition of reserve food matter. At the bicelled pro-embryonic stage there are 12 nuclei & they are arranged in a peripheral cytoplasmic layer around a central vacuole (Fig. 3G). When the embryo enter 3rd & 4th cell generation, there are sudden increase in the numbers of free endosperm unclei (Fig. 2H). Initiation of the cellular phase in endosperm commences first in the micropylar region around the embryo & gradually proceeds towards the chalazal end. The cell wall formation begins at the periphery and progress centripetally (Fig.2J)

At the advanced globular embryo stage, endosperm becomes completely cellular with a single aleurone layer (Fig. 2I). During later stage of embryo development starch grains accumulation takes place in this tissue. The embryo consume only a part of cellular endosperm in the micropylar region, rest of the part occupied by cellular endosperm (Fig. 2K). Thus, the seeds are endospermic.

Embryo Development:

The transverse division of the zygote results in the cells ca & cb (Fig. 3A). The cell cb divides transversely forming m & ci (Fig. 3B,C). The pro-embryonic tetrad produced at the end of 2nd cell generation can safely be described as T-shaped or assigned to series A2 of Soueges (1951) system of classification. During the 3rd cell generation sequential stage could not get. In the 4th cell generation tier q definitely gets demarcated into tiers I & I' Fig. 3D,E). The tier ci divides transversely & vertically into n & n' tier. The tier o & p are the derivatives of n' & forms a suspensor.

During further development tiers l & l' and m do not follow a regular sequence but occur in a different plane results in a massive globular embryo (Fig. 3F,G). The flaps of the coleoptile & stem tip, arise as bulges on one side of the embryo (Fig.3H, I). The entire tier l gives rise to the single cotyledon and cleft (upper lip of the coleoptile) organized. The tier l' contributes for the stem tip, first leaf & lower lip of the coleoptile respectively (Fig. 3L). In mature embryo pro-vascular strand joined to the plumule radicle axis (Fig. 3M). The plumule (shoot apex) is laterally disposed & enclosed by coleoptile. The shoot apex is dome shaped covered by few primordial leaves (Fig, 3N). At the radicular end there is a distinct root cap with coleorhiza covering. The mature embryo is not embedded in the endosperm but remains peripheral to it.

Seed coat and Pericarp:

The ovules are bitegmic, both the integuments are two layered. At the mature embryo sac stage both the layer of outer integument get highly stretched & gradually start degenerating (Fig. 4B). The inner integument though persists at the earlier stage, its outer layer starts collapsing at globular embryo stage, (Fig. 4C). At advanced embryo stage outer layer of inner integument disorganizes & cells of the inner layer get filled with tannin (Fig, 4D). Thus at maturity only inner layer of inner integument persist as a seed coat. (Fig. 4E).Pericarp 4-6 layers including the outer & inner epidermis layers remain constant at mature stage of the grain. (Fig. 4E). Pericarp remains free from the seed coat. The cells of the outer epidermis show thickened inner tangential walls with tannin deposition (Fig. 4E).

RESULT & DISCUSSION:

The present embryological work on *Arundinella pumila* which belongs to subfamily, Pooideae resembles in most of the embryological features of the family work out by earlier worker.

The ovules are campylotropous, bitegmic tenuinucellate & shows the feeble tendency towards Pseudocrassinucellar. The polygonum type of embryo sac development (Maheshwari, 1950). This is a very constant feature in the family investigated so far (Anderson, 1927; Beck & Harten, 1932; Chandra, 1963b, 1970; Venkateshwarlu & Devi 1964; Raju, 1980; Febulaus & Pullaiah, 1992). The three celled antipodal & antipodal complex at chalazal end in the female gametophyte in this taxon. In the Pooideae they are lateral (Chandra, 1963b; Venkateshwarly & Devi 1964; Davis, 1964; Bhanwra, 1988). Therefore, the position of antipodals has not been taken as a taxonomic character. The chief function of the hypostase is the translocation of nutrients; it may acts as a secondary storage tissue. This observation is supported by the findings of present paper. The endosperm development is free nuclear earlier but later on it becomes cellular at the end of globular or avdvanced embryo phase & the meristematic activity in peripheral layer of endosperm which forms a characterisitic feature of the family (Narayanswami, 1953, 1955a,b,c, 1956; Chandra, 1963; Sapre, 1964; Johri & Ambegaonkar, 1976.)

The embryo development conforms to the Asterad type of Johansen (1950). According to Soueges (1951) the development conforms to grand period I, series A, subseries A2 & megarche type II. The creation of a new variation viz, 'Graminad Type' on the basis of oblique plane during pro-embryonic development by Batygina (1969a,b). This is criticised by Gerassimova-Navaschina (1977).

The fruit in grasses is classified under Caryopsis and has been define as seed. The testa and pericarp are further reported to be fused with each other (Anderson, 1927, Julien and Aldama , 1939). However data available from later studies on grasses do not agree with these findings (Narayanswami, 1955 a, b, c; Raju, 1980; Bhanwara, 1988; Ghaisas, 1991; Despande and Makde, 1994; Nikhade and Makde, 1997). The present study also testifies to this. Sendulsky et. Al. (1986) stated that caryopsis essentially is dry indehiscent fruit where pericarp is free or closely adherent to seed coat the author feels that in the light of theses finding there is an urgent need to redefine the term caryopsis.

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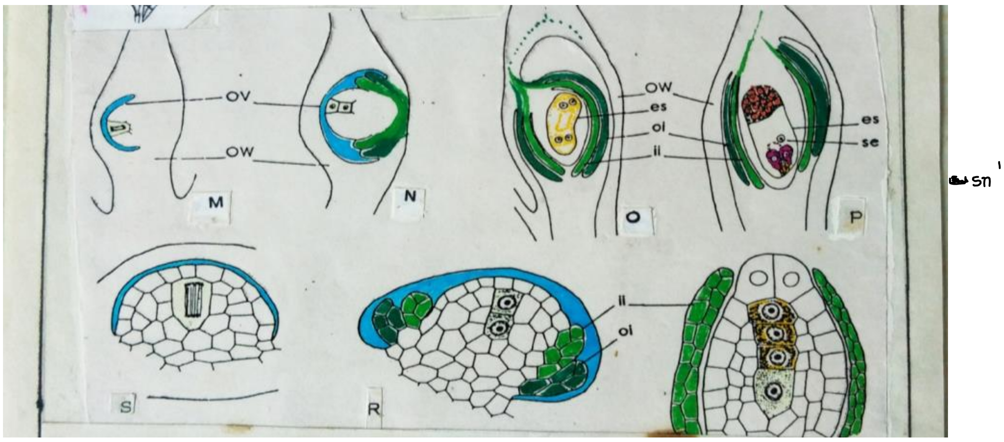
FIGURE 1



Fig, 1M-S; Megasporogenesis & Female Gametophyte Development. M-P. L.S. ovary (diagrammatic) Development of campylotropous ovule. (es, embryo sac ; sn, secondary nucleus ; ii, inner integument ; oi; outer integument ; ov, overy; ow, overy wall;)

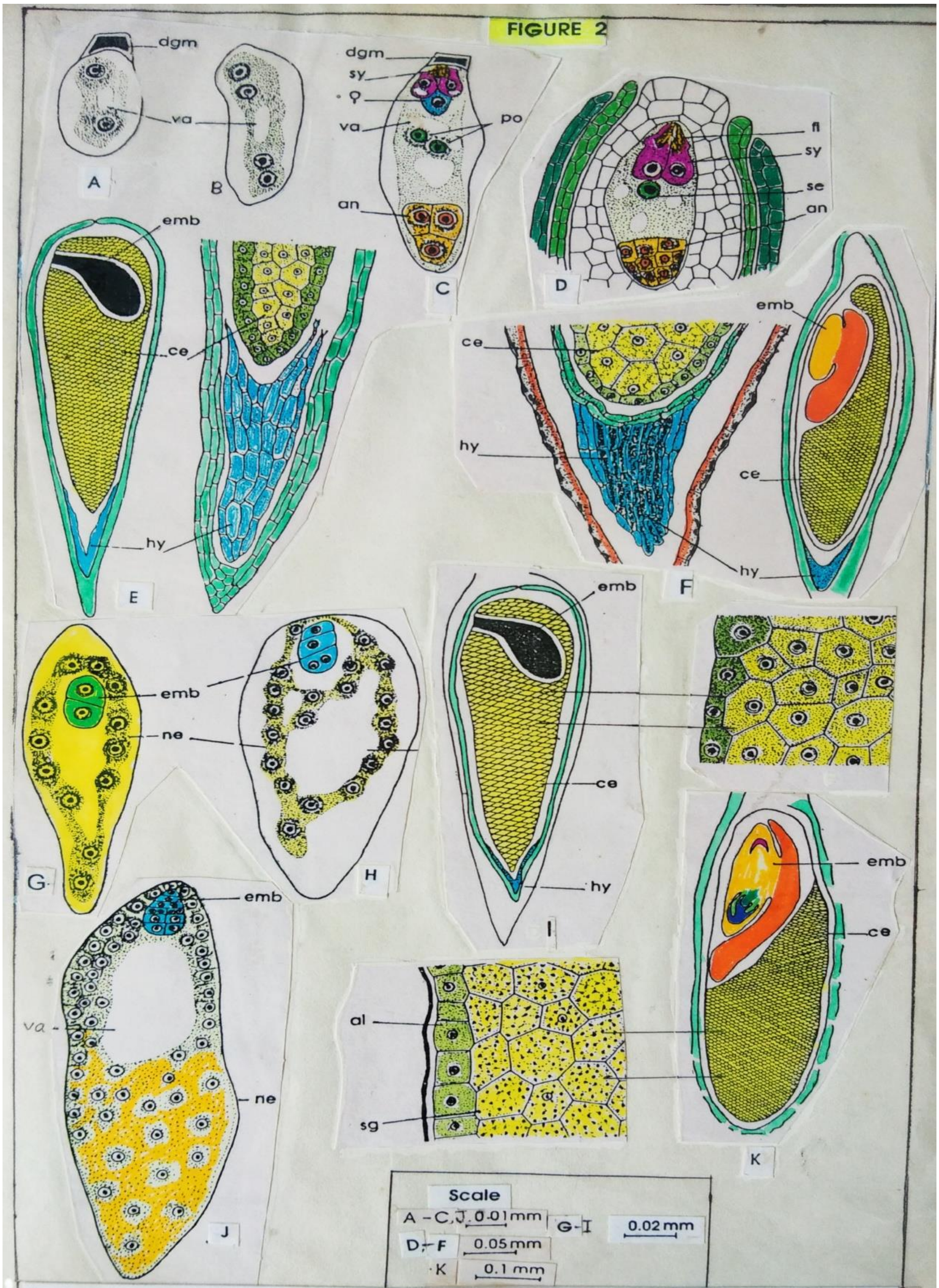


Fig.2.A-K, *Arundinella Pumila*. A, B. (2 and 4-nucleate Embryo Sac); C, D. Mature Embyro Sac (Rudimentary nucellar beak); E.L.S. developing grain (Diagramatic); F.L.S. Mature grain. G.K. Endosperm development. G, H Free Nuclear Endosperm; J. Beginning of cellularization; I.K. cellular endosperm. (al, aleuron layer; an, antipodal complex; ce, cellular endosperm; dgm, degenerating megaspore; emb, embryo; fi, filiform apparatus; hy, hypostase; sg, starch grain; va, vacuole; s, suspensor).

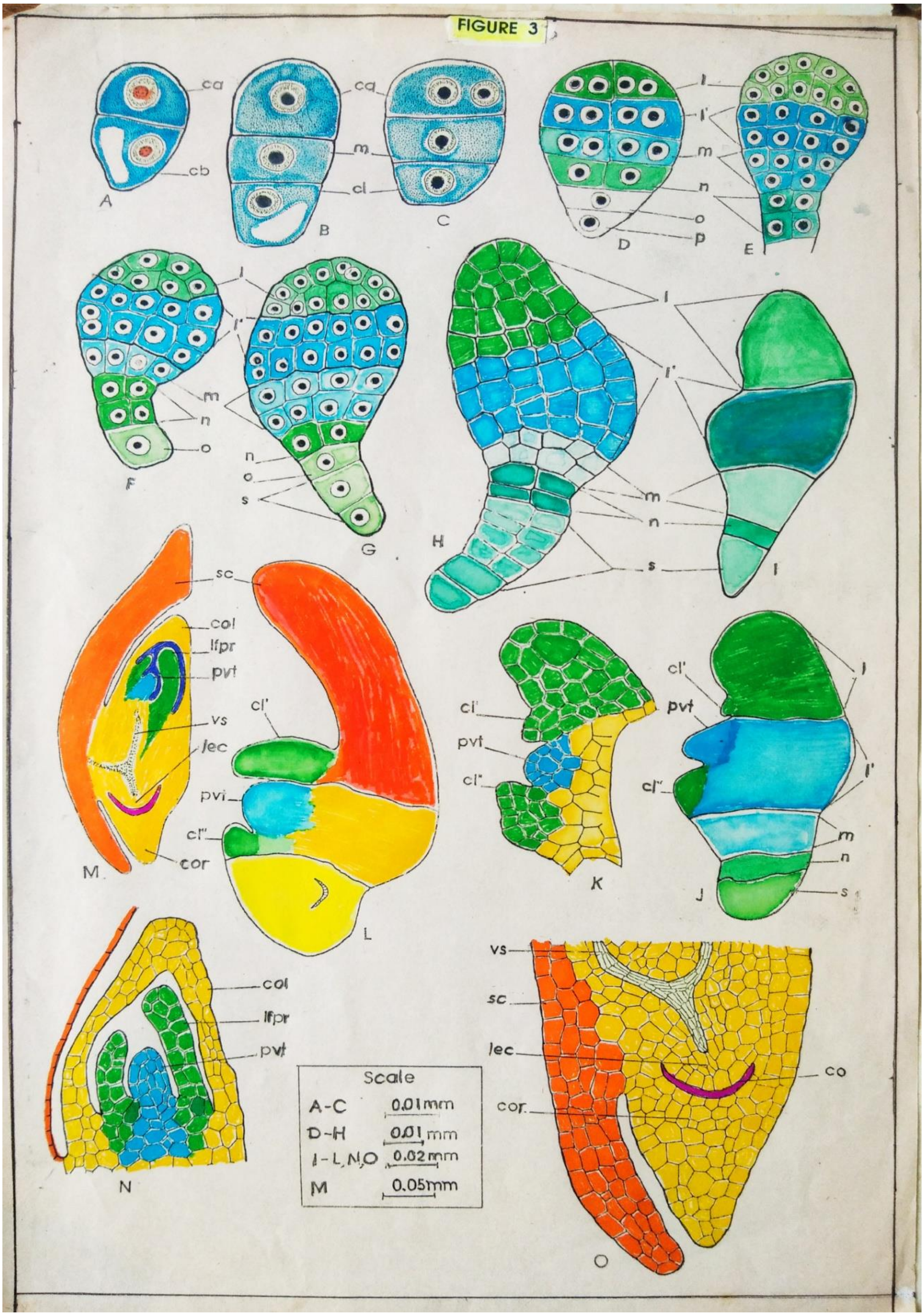


Fig.3 A-O-Stages in the development of embryo. (co,root cap; col, coleoptile; cor, coleorhiza; cl' cleft one; cleft two; iec, initial of the root cortex; lfpr, leaf primordia; pvt, stem tip; sc, scutellum; s, suspensor).

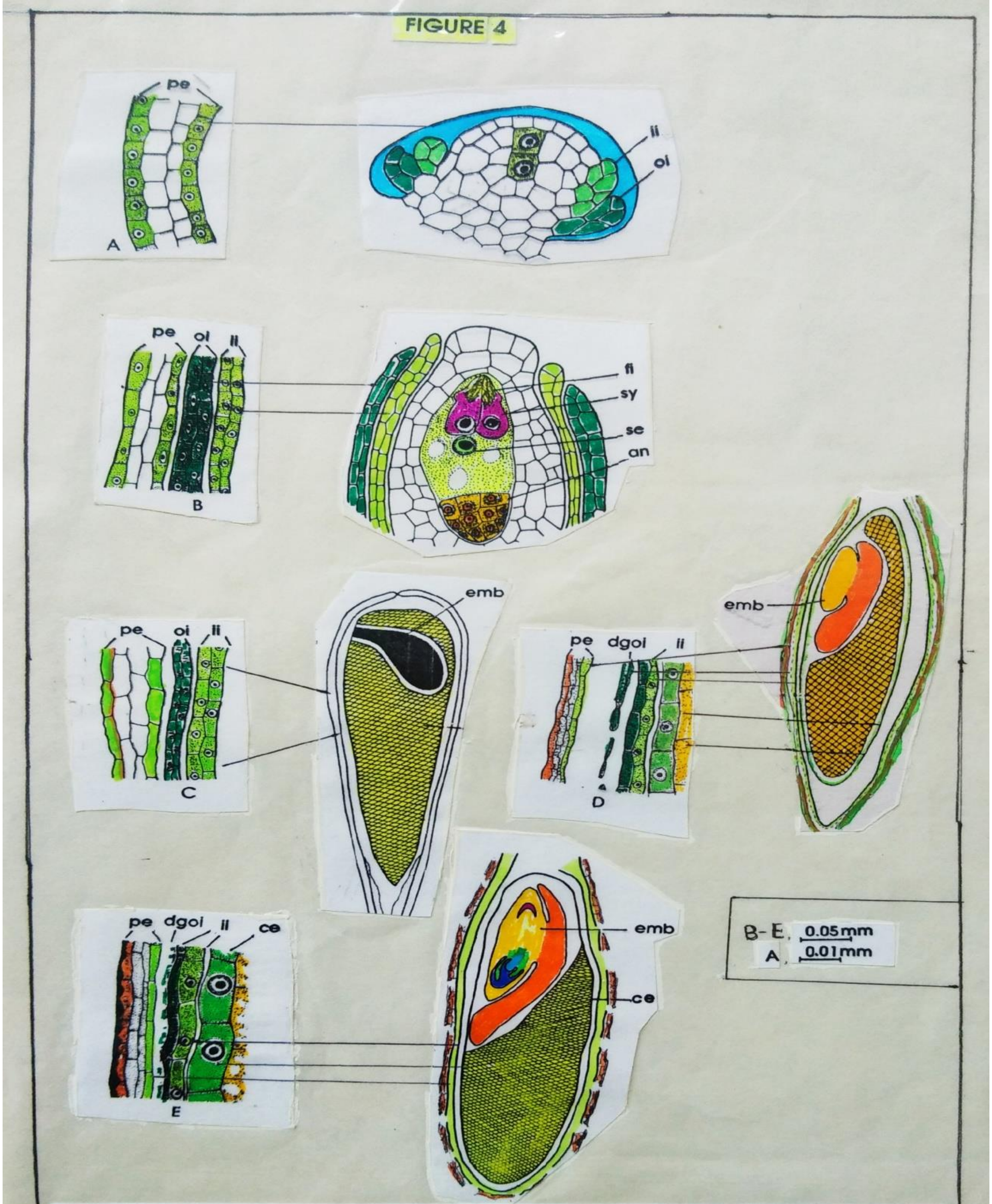


Fig.4. A-E *Arundinella Pumila*. Stages in the development of Seed coat & pericarp.

A. Pericarp at megaspore dyad stage & inition of outer & inner integuments.

B. Pericarp & integuments (part) at mature embryo sac stage.

C. Pericarp & integuments (part) at globular embryo stage; note obliteration of outer integument.

D. Pericarp & integuments (part) at advanced embryo stage; note degenerated outer integument

E. Pericarp & integument (part) at mature embryo stage; note tannin deposition in the outer epidermis of pericarp, degenerated outer integument & obliteration of outer layer of inner integument.