MORPHOLOGY AND ANATOMY OF THE FRUIT AND SEED IN DEVELOPMENT OF *EUPHORBIA HELIOSCOPIA* L. *(EUPHORBIACEAE JUSS.)*

Ramona Crina GALEŞ*, Constantin TOMA, Lăcrămioara IVĂNESCU
"Al. I. Cuza" University of Iasi, Faculty of Biology

*** Correspondence:** Galeş Ramona Crina, Universitatea "Al. I. Cuza", Faculty of Biology, Department of Biology, Carol I Bd., no. 20A, 700506, Iaşi, Romania, e-mail: ramonarotari@yahoo.com
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ABSTRACT. The aim of this study is to determine the histo-anatomical peculiarities of the fruit and seed in development of *Euphorbia helioscopia* L. with relation to taxonomy and ecology.

Keywords: *Euphorbia helioscopia,* fruit, seed, development, morphology, anatomy, ecology, taxonomy

INTRODUCTION

Euphorbia helioscopia is an annual invasive weed that dominates many arable lands from Romania and relatively little is known about its ontogenesis cycle, especially from a structural perspective. From ecological point of view, it is a xerophilous plant, its vegetation period being very short (Prodan, 1953).

The foreign literature on embryology and carpology in other *Euphorbia* species is quit rich. The aim of these studies is to evidence the cito-histological features of the ovary and ovule development during ontogenesis (Raja and Prakasa, 1975; Gori 1987; Bhanwra, 1987; Carmichael and Selbo, 1999), as well as to identify the morphological and anatomical characters with implications in phylogeny, systematic and ecology of *Euphorbia* genus (Tokuoka şi Tobe, 1995, 2002; Strasburger, 1998; Chaturvedi and Dalal, 2000; Esser, 2003).

In a recent study (Galeş and Toma, 2008) we analyzed the development on the vegetative apparatus in *Euphorbia helioscopia*, and in this paper we investigate the morphology and structure of the fruit and seed during ontogenesis related to the habitat and pollination type, underlining the histo-anatomical peculiarities of these organs which serve as elements of species diagnosis.

MATERIALS AND METHODS

The material represented by mature cyathia, fruits and seeds of *Euphorbia helioscopia*, collected from an arable land from Rădăuţi, Suceava County (Romania), was fixed in FEEA mixture and preserved in 70% ethylic alcohol. Fixed samples were dehydrated by a passage through ethanol/water solutions and then embedded in paraffin at 65ºC for 24 hours. The embedded material was cut into 13 µm thick sections with a rotator microtome. The dried serial sections were deparaffinized, rehydrated in serial dilutions of ethanol (100%, 90%, and 70%), coloured with metilen-blue and ruthenium-red, and finally mounted in Canada balsam.

The permanent slides were analyzed in the light microscopy, using a Novex (Holland) microscope; the micro-photos were made at the same microscope with a Sanyo digital camera.

RESULTS AND DISCUSSIONS

Fruit development (Plate I)

The ovary of the mature female flower of *E. helioscopia* cyathium is 3-carpellar, syncarpous, 3-locullar with central-marginal placentation.

The onelayered outer epidermis of the ovary wall shows xeromorphous characters, as follows: (1) all epidermis cells evidence a papilla-shaped prominence in the middle of the external wall, the latest one being more thicker then the other walls and covered by cuticle; (2) the stomata are founded under the external level of the epidermis, having small guard cells, deep epistomatal chamber and large substomatal chamber limited by palisade cells. The ovarian mesophyll is cellulosic – parenchymatous, relatively compact and heterogeneous, being composed of a layer with slightly high cells (immediately under the external epidermis), 4-5 layers of rounded cells (in the central part), following by a layer of high palisade cells and probably few layers of tangentially elongated cells, which are mighty crushed under the internal epidermis (Fig. 1).

The exocarp of the fruit derives from the external epidermis of the ovary, which does not undergo significant histological transformations, its component cells being of papilla-shaped but shorter.

The mesocarp derives from the ovarian mesophyll. The palisade cells undergo a gradual radially elongation and their walls become partly lignified. In the thickness of mesocarp small vascular bundles and numerous laticifers of variable diameter may be observed.

During the fruit development, the internal epidermis is partly disorganized. The endocarp derives from the subadjacent layers of the internal epidermis (Fig. 2).

As in the majority of the *Euphorbia* species, the *E. helioscopia* fruit is represented by a capsule with septicidal dorsicidal and septifragal dehiscence, being adapted for anemochory (Roth, 1977; Strasburger, 1998). During ontogenesis, the fruit has green colour.

In cross-section (Fig. 3), the fruit conserves the mature ovary shape, being approximately triangular, with rounded angles. The three large depressions, each one comprising two vascular bundles, represent the places of the carpels fusion. The three deep ditches, each one comprising a single vascular bundle, mark the median nervure of each carpel. The central part of the fruit represents the collumela, which comprises three big vascular bundles.

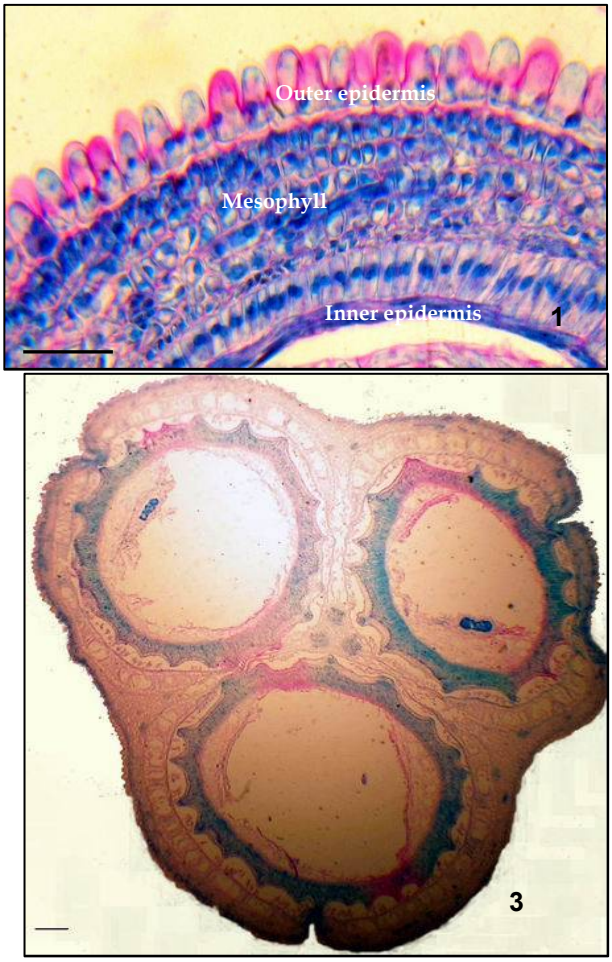


Plate I. Fruit development in *Euphorbia helioscopia* L.
Fig. 1. Cross-section from the mature ovary wall.
Fig. 2. Cross-section from the ovary wall during fruit development.
Fig. 3 Cross-section from the ovary during fruit development. (orig. photos., scale bars = 50μm)

Seed development (Plate II)

The mature ovule is anatropus, crassinucellar and bitegmic, having a well-defined nucellar epidermis with relatively big cells.

Tokuoka and Tobe (1995) suggested that only the following five of over 50 embryological characters of ovules and seeds are likely to be useful for comparison between and within the subfamilies of *Euphorbiceae* families: (1) the presence or absence of vascular bundles in the inner integument; (2) whether the inner integument is thick or thin; (3) whether ovules or seeds are pachychalazal or not; (4) whether seeds are arillate or not; (5) whether an exotegmen is fibrous or not. In 2002, the same authors mentioned that within the *Euphorbiaceae* family and also within *Euphorbia* genus, there is a morpho-structural diversity of ovules and seeds, given by three characters: (1) the thickness of the inner integument, (2) the thickness of the outer integument, and (3) the presence or absence of an aril.

In our analyzed species, the outer integument of the ovule is very thin; both onelayered epidermises and the two parenchymatous layers (only one hear and there) between them consist of small cells. In the micropyllar region of the ovule, the outer integument is thicker than in the other parts and some of its cells intensively proliferate, given born to a caruncle (Fig. 4).

The inner integument is thick and consists of an external onelayered epidermis with high cells, 5-6 layers of cellulosic-parenchymatous cells and an onelayered internal epidermis with small and slightly elongated cells.

An obturator consist of elongated cells derives from the placenta and penetrates the micropyle and the style duct, having role in the guidance of the pollen tube towards the micropyle, after Baillon's statement (1858) (cf. Weninger, 1917).

The embryo sac is elongated. After fecundation, the first divisions of the triploid zygote are not followed immediately by cytokinesis; thus a secondary nuclear endosperm results. In this stage of development the embryo sac shows a parietal layer of cytoplasm (in which there are nuclei of the secondary endosperm) and a big central vacuole (Fig. 5). In the embryo region

and in the chalazal end of the endosperm, big congestions of cytoplasm and nuclei may be observed.

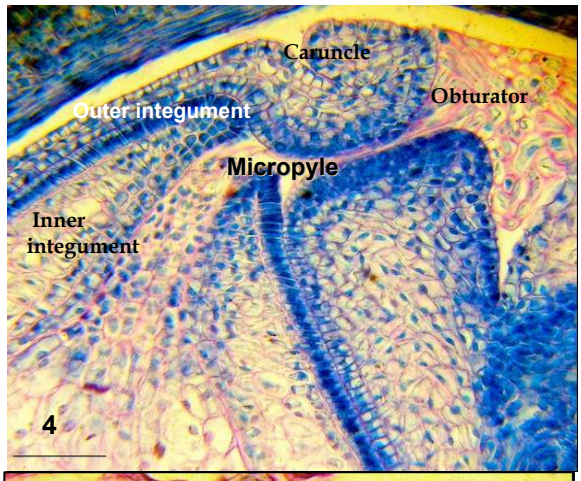
The seed coat (Fig. 6) develops from the two integuments of the ovules and consists of epidermis, testa and tegmen.

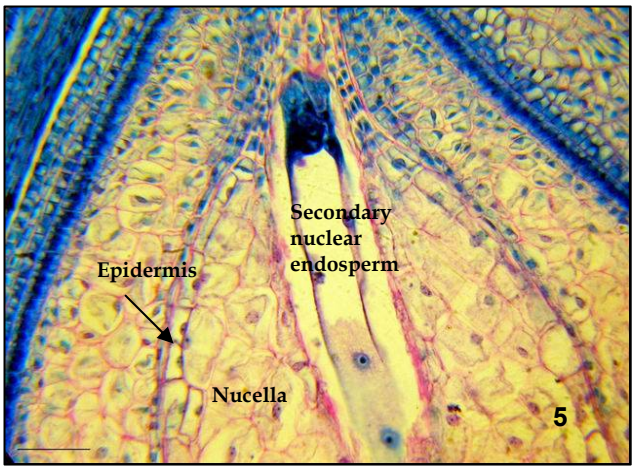
The epidermis derives from the external epidermis of the outer integument.

The testa derives from the parenchymatous tissue and internal epidermis of the outer integument and external epidermis of the inner integument; the latest one undergoes visible histological manifestations, transforming in a horny layer consisted of radially elongated cells with sclerified and lignified walls. Beside, Tokuoka şi Tobe (1995) underline, that from histological point of view, in all the species of *Euphorbiaceae* family, the seeds present a palisade persistent exotegmen, consisted of small radially elongated cells with sclerified walls.

The tegmen derives from the parenchymatous tissue and the internal epidermis of the inner integument.

From morphological point of view, the *E. helioscopia* seed has oval shape, brown-grey colour and presents two appendages: (1) a white and very prominent caruncle and (2) a raphe which appear as a longitudinal black ridge from the hillum to the chalaza. The seed surface is reticular, presenting "large depressions" arranged in longitudinal lines (Figures 7, 8).





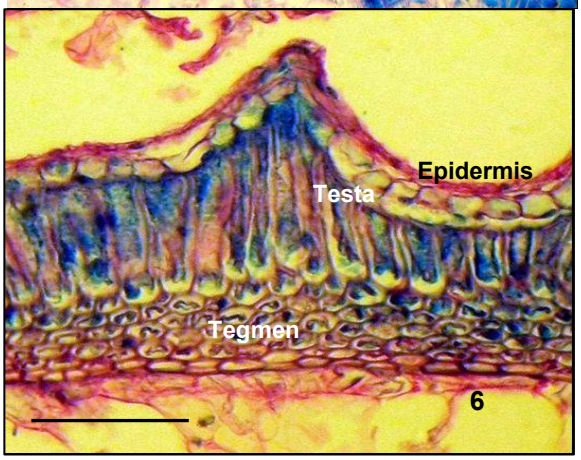


Plate II. Seed development in *Euphorbia helioscopia* L.
Fig. 4, 5. Longitudinal sections from the ovule, after fecundation.
Fig. 6. Cross-section from the seminal tegument.
Fig. 7. Seed in ventral view.
Fig. 8. Seed in dorsal view. (orig. photos., scale bars = 50µm)

CONCLUSIONS

Certain morphological and histo-anatomical peculiarities of the ovules and seeds during development represent elements of *Euphorbia helioscopia* diagnosis i. e., the inner integument of the ovule is thick; the inner integument does not comprises vascular bundles; the seed surface is reticular; the seed has caruncle and raphe; the testa of the seed coat is fibrous.

During fruit development, anatomo-ecological characters related to xerophily may be underline, as follows: the external epidermis of the ovary and fruit consists of papilla-shaped cells and stomata which have deep epistomatal chambers; the ovarian mesophyll is relatively compact.

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