

CONTRIBUTIONS TO THE EMBRYOLOGICAL STUDY OF THE
FAMILY VITACEAE II (DEVELOPMENT OF THE FEMALE
GAMETOPHYTE IN PARTHENOCISSUS QUINQUEFOLIA (L. Planch.)

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An embryological study of *Parthenocissus quinquefolia* (L.) Planch. belonging in the family *Vitaceae* is made. Morphological peculiarities of the development of the ovules are shown together with the stages of development of the female gametophyte, the organising of the embryo-sac, the occurring of fertilization and the beginning of differentiation in the secondary endosperm of the nuclear type and in the proembryo. Peculiarities of the development of the female gametophyte in this species are stressed and compared to data on other representatives of the family *Vitaceae* as known from the literature.

The genus *Parthenocissus* is one of the 12 genera included in the family *Vitaceae*. There are relatively few embryological studies of the representatives of this family, as mostly dealt with was the genus *Vitis* and more particularly the cultivated varieties obtained from *Vitis vinifera* L. in view of their economical significance (P. A. BARANOV, 1946).

B. C. MULAY, N. C. NAIR and M.S.R.K. SASTRY (1953) studied the particularities of the development of the male and female gametophytes in *Vitis pedata* while N. C. NAIR and Y. P. S. BAJAJ (1966) dealt with the same phenomena in *Cyphostemma setosum* (Wall.) Alston.

In the literature of speciality I found no data on the peculiarities of the development of the female and male gametophytes in the representatives of the genus *Parthenocissus*. I studied the development of the female gametophyte in *Parthenocissus quinquefolia* (L.) Planch.

I studied a number of gynoecia at different stages of development, tracing the growth of the ovules and the simultaneous development of the embryo-sac, the phenomenon of fertilization and the beginning of seed differentiation.

The embryological material was fixed in Navashin-Bruun mixture, in fixatives Carnoy and Carnoy modified by Gerassimova. Inclusions in paraffin and sectioning at 6 to 8 μ for younger stages and at 12 to 14 μ for adult stages were made. Preparations were stained in Ehrlich haematoxylin.

Description of the morphological peculiarities of the development of the female gametophyte in *Parthenocissus quinquefolia* (L.) Planch. is given hereunder. Particularities of the development of the male gametophyte in this species were described in a previous paper (I. T. TARNAVSCHI and ELENA PETRIA, 1968).

Parthenocissus quinquefolia (L.) Planch. is a robust creeper originating from North America. It is cultivated for its ornamental qualities, to cover walls. It presents bisexual flowers: cup-like pentamerous calyx; pentamerous dialipetalous corolla; androceus consisting of 5 stamens; bicarpellar, coenocarpeous, bilocular gynoecium, 2 ovules developing in each locule. Ovary pyriform, having very short style and reduced stigmatate. The ovules develop at the carpellar base. They are anatropous-apotropous ascendant, bitegmic and crassinucellate. In initial stages of development of the ovules the ovarian cavity is triangular in shape both toward the style and in the micropylar area. When ovules are fully developed the ovarian cavity becomes reduced as a narrow space surrounding the ovules.

At the beginning, a uniform cellular prominence appears from the carpellar base in the ovarian cavity, representing the primordial ovule. While growing, the latter undergoes a lateral curving in the ovarian cavity. At the top of the prominence, subepidermally, in the young nucella a large cell, rich in plasma and having a large nucleus is distinguished. This undergoes periclinal division to produce a parietal cell outwardly and a macrosporal (megasporal) mother cell inwardly (Figs. 1, 2).

The macrosporal cell increases rapidly in mass and undergoes meiotic division to produce two cells, then again equational division to obtain a linear tetrad of macrospores (Figs. 3—6). During this time the nucella hardly differentiates at all while the inner integument and the outer integument opposite the funicular side appear and become developed.

The nucleus of the last macrospore soon starts dividing while the remaining 3 apical macrospores are still distinguished and the caps have not yet started differentiation (Fig. 7).

Between the first division of the fourth macrospore — now the mother cell of the embryo-sac — and its second division a rapid development of the ovule body occurs, namely: the nucellar cap is formed following repeated, periclinal and anticlinal division of the parietal cell, made of 10 to 12 cellular layers, and also the epidermal cap as a result of repeated division of one epidermal cell of the nucella, made of 5—7 cell layers.

At the time when the caps are entirely developed, the inner integument made of 3 (4) cell layers covers the nucella and delimits the micropyle apically while the outer integument, consisting of 5 (6) cell layers opposite the funicule reaches the apical level of the nucella. At

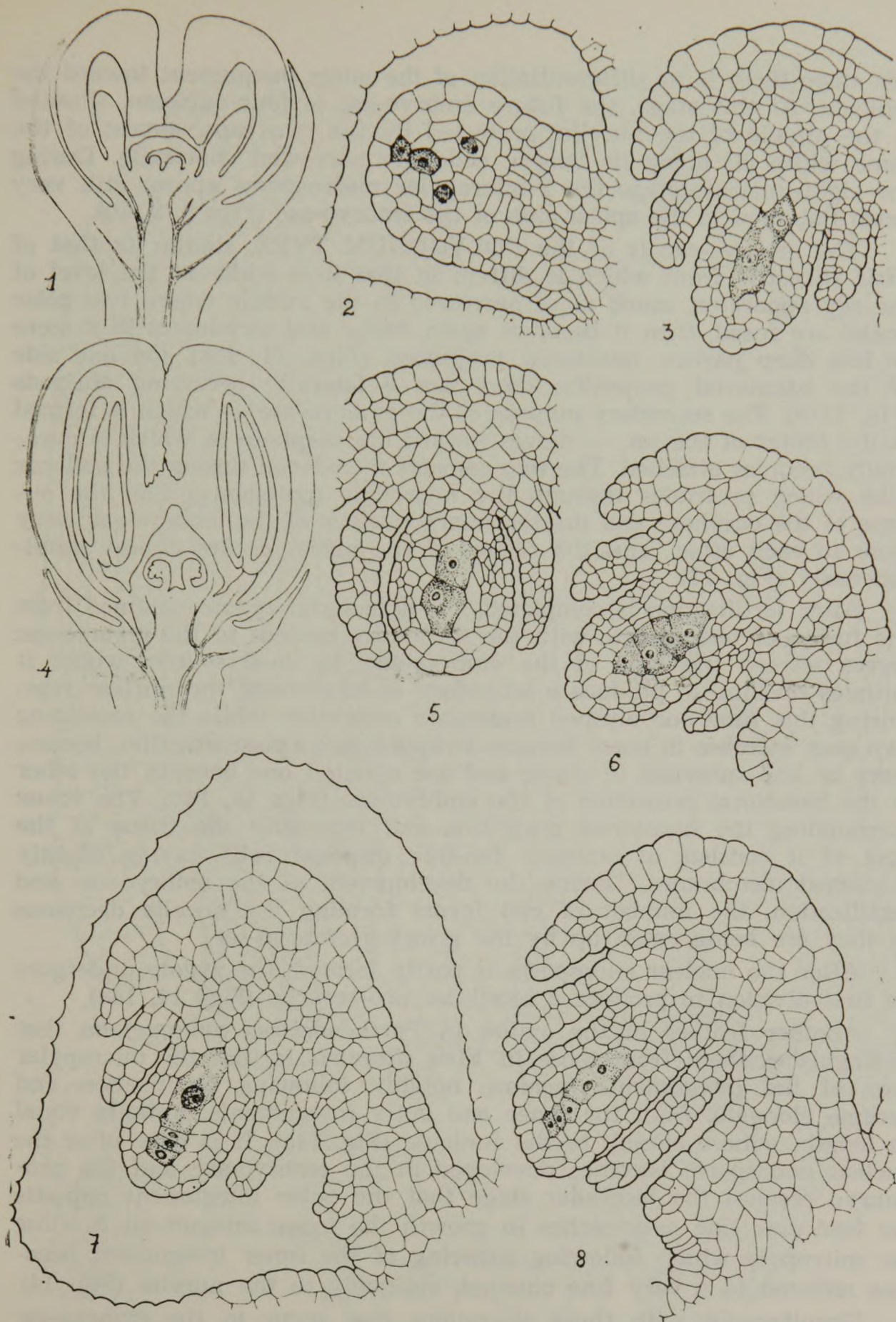


PLATE I. *Parthenocissus quinquefolia* (L.) Planch.

Text-Figs. 1—8. Ovule and flower in longisection. 1—5, young ovule in longisection showing macrosporal mother cell ; 6, nucellus in longisection to show linear tetrad of macrospores ; 7, a linear tetrad with the fourth macrospore functioning ; 8, two nucleate female gametophyte. Drawing 1,4 = 50 \times ; 2, 3, 5—8 = 440 \times . Original.

this stage there is no differentiation of the outer integument toward the funiculus. At this stage, the future embryo-sac is four-nucleate, situated in the middle of the nucella, protected by the two caps, almost of the same width all along its length, suddenly narrowed chalazally. During the eight-nucleate stage the 2 micropylar macrospores appear still very much flattened in the apical area of the embryo-sac (Figs 8, 9, 10).

The embryo-sac is of the POLYGONUM TYPE, similar to that of *Vitis silvestris* from which it differs in that it is wider at the level of the egg apparatus, much more narrowed in the middle where two polar nuclei are fused, then it becomes again wider and terminates in a more or less deep narrow haustorial projection (Figs. 11, 11a). On one side of the haustorial projection there are 3 laterally occurring antipods (Fig. 12 b). The secondary nucleus of the embryo-sac — which is formed at the center of the sac — moves toward the oosphere to which it eventually becomes attached. The two gametes introduced through the pollinar tube which protrudes through the micropyle (porogamy) find the nucleus of the oosphere and the secondary nucleus of the embryo-sac, very close to each other, and the fusion of the nuclei occurs almost simultaneously (Fig. 13).

After fertilization is completed, the accessory zygote obtained from the fusion of one gamete with the secondary nucleus of the embryo-sac moves toward the base of the embryo-sac, its food source, where it initiates division to produce a secondary endosperm of the nuclear type. During this time one antipod undergoes resorption while the remaining two ones increase in mass, become wrapped into a plasmatic film, become more or less spherical in shape and are situated one beneath the other in the haustorial projection of the embryo-sac (Figs 14, 14b). The tissue surrounding the haustorial projection and especially the tissue at the base of it consists of elongate fan-like disposed cells having slightly thickened membranes. During the development of the embryo-sac and fertilization, the number of cell layers forming the nucella decreases as they are being eaten up by the growing embryo-sac.

After the nuclear endosperm is partly formed, the zygote undergoes its first division to produce a bicellular pro-embryo (Figs 14, 14a).

Another feature of the ovules in *Parthenocissus quinquefolia* that distinguishes them from those in *Vitis silvestris* is that the micropylar area of the integuments increase notably following fertilization and become elongate. Both the inner and outer integuments, initially equal in length, adhere closely to the funiculus (Fig. 14a). It is only after the nuclear endosperm becomes developed in the embryo-sac and the pro-embryo reaches the bicellular stage that the outer integument opposite the funicular side overreaches in growth the inner integument to close the micropyle which following adhering of the inner integument becomes reduced to a very fine channel, obliquely to the nucella (Fig. 14)

Simultaneous with these alterations that occur in the embryo-sac and in the micropylar area of the ovule, the cell layers of integuments undergo differentiation to produce the seed tegumen similarly as in *Vitis silvestris*. But unlike in the latter species, the chalaza moves in

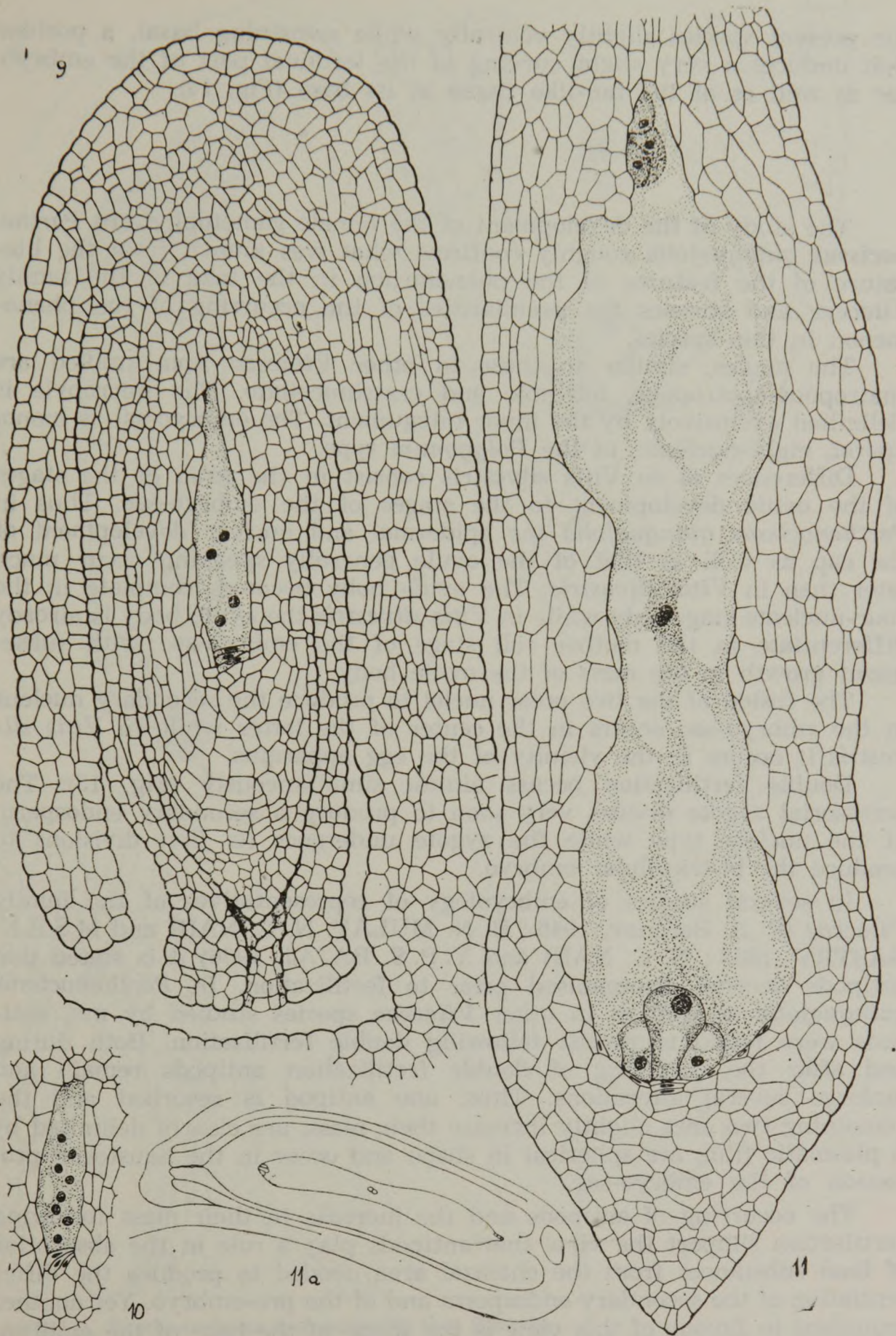


PLATE II. *Parthenocissus quinquefolia* (L.) Planch.

Text-Figs. 9—11. Ovule in longisection; development of ovule and embryo-sac. Embryo-sac before fusion of polar nuclei, 11 a — embryo-sac developed.

Drawing = 440 X. Original.

the present species slightly ventrally while remaining basal, a position that induces a very slight curving of the terminal part of the embryo-sac as well as of the fan-like tissue at its base (Fig. 14).

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The study of the development of the female gametophyte in *Parthenocissus quinquefolia* roughly confirms what was known from the literature of the features of the phenomenon in the taxa of the family *Vitaceae* and stresses the peculiarities of the occurring of the phenomenon in this species.

The ovules, similar to those in other *Vitaceae* taxa studied are anatropous-apotropous, bitegmic and crassinucellate. The micropyle is delimited exclusively by the inner integument. The embryo-sac is monosporal, eight-nucleate, of the *Polygonum* type.

Differences as to *Vitis silvestris* consist in the ratio of the stages of the ovule development to the stages of the embryo-sac. Thus in *Parthenocissus quinquefolia* the epidermal and nuclear development of the cap as well as that of the ovule generally speaking occur much later than in *Vitis silvestris*. The ovule body becomes complete in the four-nucleate stage only while in *Vitis silvestris* the ovule body is already differentiated in the mother cell stage of the embryo-sac with subsequent growth in the mass of the ovule body.

The fusion of the two polar nuclei to produce the secondary nucleus in the embryo-sac occurs in the center of the latter while in *Vitis silvestris* it occurs in the vicinity of the egg apparatus.

Double fertilization occurs almost simultaneously (Fig. 13). The accessorial zygote divides very soon to produce a secondary endosperm of the nuclear type while the zygote undergoes its first divisions to produce the bi-tricellular embryo.

In several studies of embryology of representatives of the family *Vitaceae* (P. A. Baranov, 1946 ; B. N. MULAY, N. C. NAIR and M.S.R.K. SASTRY, 1953 ; N. C. NAIR and Y. P. S. BAJAJ, 1966) it is stated that antipods become disorganised prior to fertilization. In *Parthenocissus quinquefolia* as well as in other *Vitaceae* species studied by me, antipods were found to persist following double fertilization. Both during and after the occurring of double fertilization antipods remain and undergo several alterations. Thus, one antipod is resorbed and the remaining two ones slightly increase their mass, are clearly delimited by a plasmatic film, are spherical in shape and occur in the haustorial projection of the embryo-sac.

The occurring of antipods and the increase in their mass following fertilization support the view that antipods play a role in the absorption of food substances from the chalazal area needed to produce the differentiation of the secondary endosperm and of the pro-embryo. Yet another argument in favour of this view is the shape of the base of the embryo-sac, which consists of elongate, fan-like toward the chalaza, cells that play a role in conducting food substances.

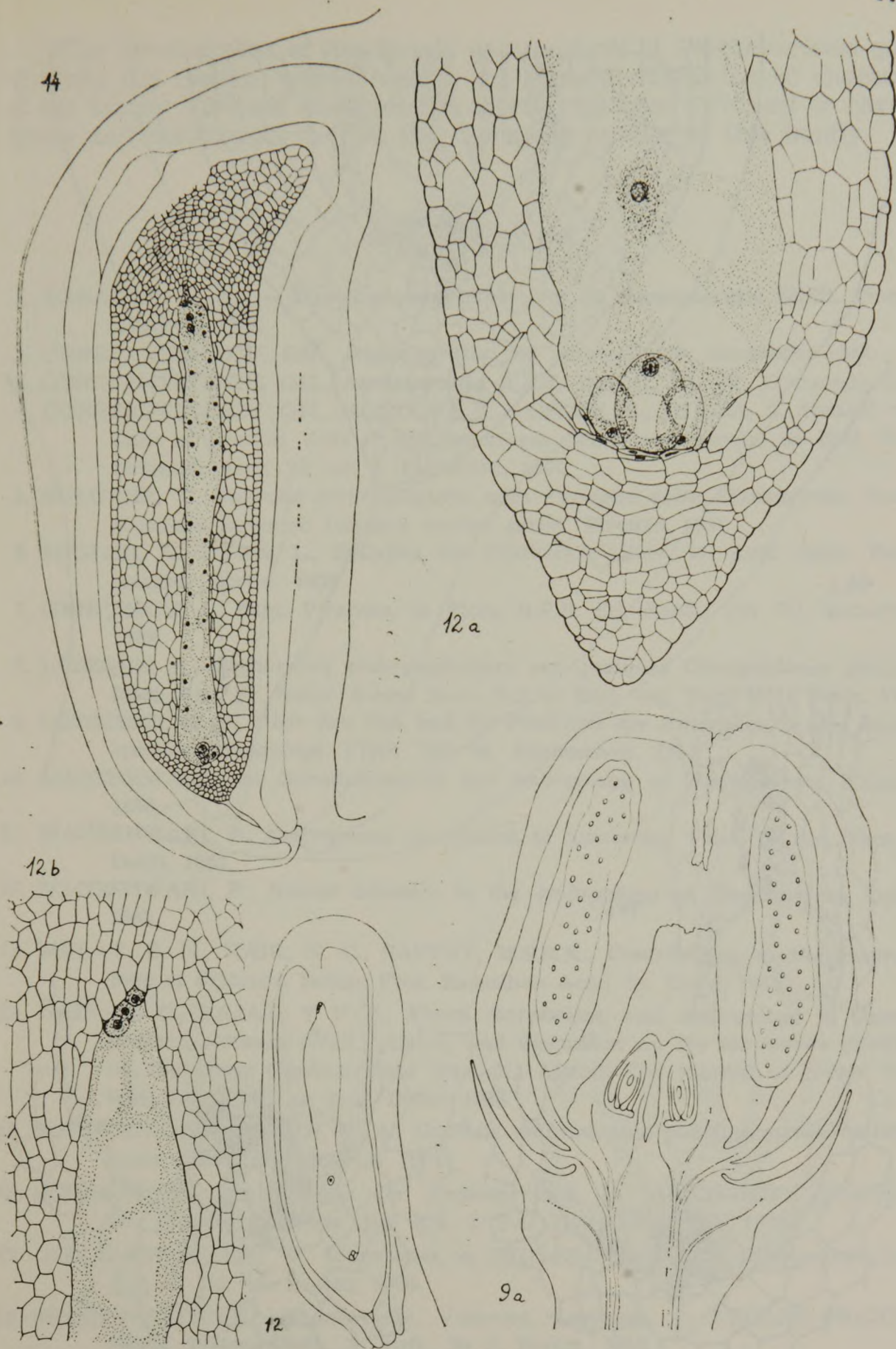


PLATE III. *Parthenocissus quinquefolia* (L.) Planch.

Text-Figs. 9 a. Flower in long section ; 12, 14, Ovule in long section. Mature embryo-sac, 14 — stages in the development of embryo (bi-cells pro-embryo) ; stages in the development of endosperm.

Drawing 9 a = 50 X ; 12 = 440 X. Original.

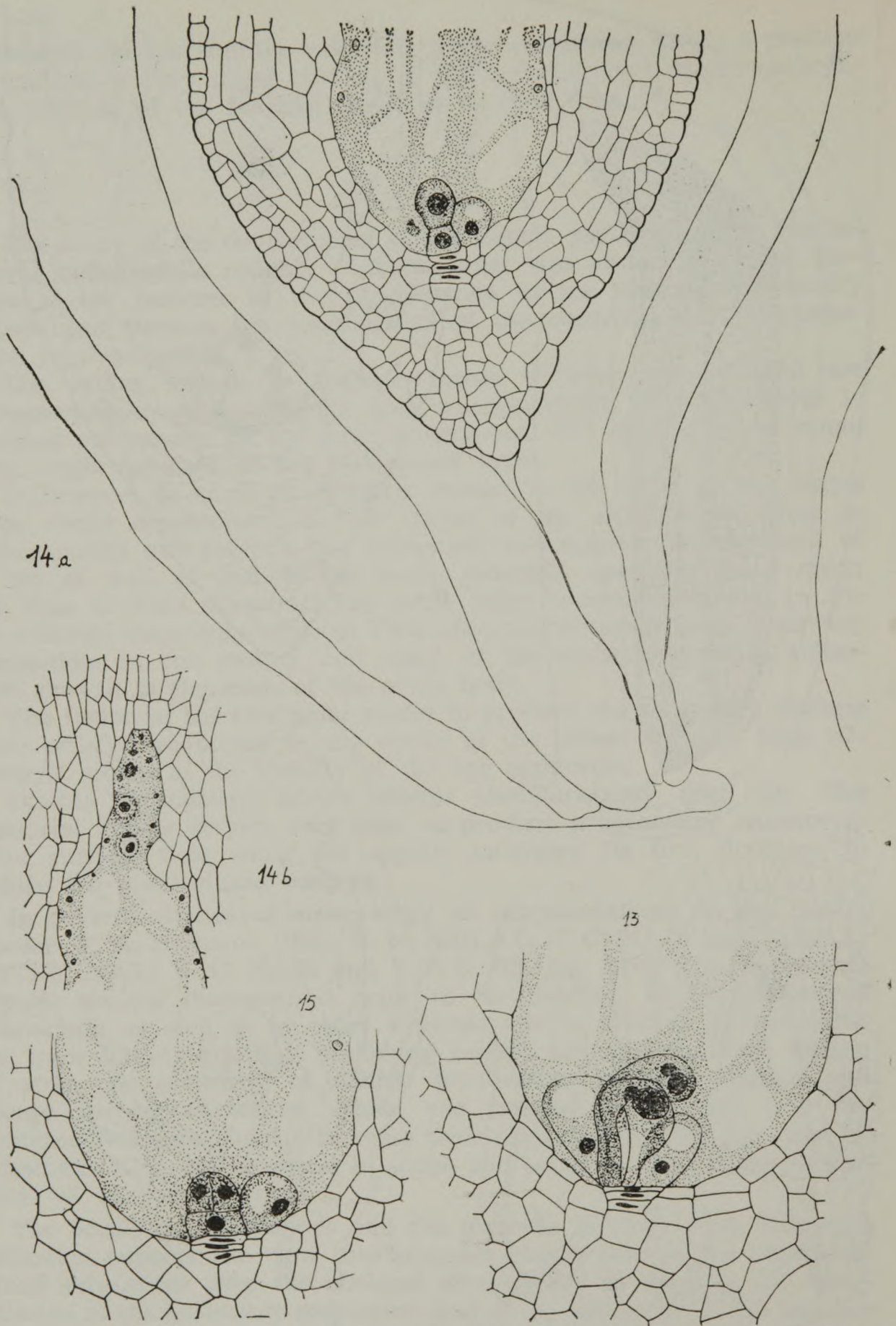


PLATE IV. *Parthenocissus quinquefolia* (L.) Planch.

Text.-Figs. 13—15. Simultaneous fertilization, stages in the development of nuclear endosperm, the nucellus is stiped and the endosperm cross hatched; 13 — tricells embryo.

Drawing 13 = 550 X; 14—15 = 440 X Original.

The development of the female gametophyte in *Parthenocissus quinquefolia* (L.) Planch. while showing the general embryological characters of the family *Vitaceae* also presents specific features sufficient to characterize and distinguish it from the remaining species of this family.

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CONTRIBUȚII LA STUDIUL EMBRIOLOGIC AL FAMILIEI
VITACEAE II. (DEZVOLTAREA GAMETOFITULUI FEMENIN
LA PARTHENOCISSUS QUINQUEFOLIA (L.) PLANCH.

Re z u m a t

S-a analizat din punct de vedere embriologic *Parthenocissus quinquefolia* (L.) Planch., din familia *Vitaceae*. S-au stabilit particularitățile morfologice în procesul dezvoltării ovulelor și paralel cu aceasta a etapelor dezvoltării gametofitului feminin, a organizării sacului embrionar, a desfășurării fenomenului de fecundație și începutul diferențierii endospermului secundar de tip nuclear și a proembrionului. S-au scos în evidență particularitățile dezvoltării gametofitului feminin la această specie în raport cu datele cunoscute din literatura de specialitate, despre alți reprezentanți ai familiei *Vitaceae*.