CONTRIBUTION TO THE MORPHOLOGY OF

ECLIPTA ERECTA, LINN.

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1. Introduction.

Eclipta erecta, Linn., a member of the tribe Helianthoideae of the family Compositae, is a common weed found in moist places in many parts of India. It flowers during the greater part of the year and is distributed throughout the warmer countries of the world.

The family Compositae has received considerable attention from morphologists, and a number of variations have been recorded of which the more important are summarised here.

Male gametophyte.—In the development of the microspores, the tapetum becomes amoeboid in some plants though in most cases it is an ordinary glandular layer. Chiarugi (1927b) has worked on several species of the Compositae and he concludes that the anther tapetum in this family is not of a uniform type but shows a progressive tendency towards the formation of a true periplasmodium. Division of the microspore mother cells is simultaneous and cytokinesis has been found to occur in many cases by furrowing.

The division of the generative cell commonly occurs in the pollen grain which is three-nucleate at the time of shedding.

Usually each pollen grain has three germ pores but Wodehouse (1931) has recently reported the presence of six germ pores in *Dahlia*.

Ovule.—In all the members of Compositae so far investigated the ovules are anatropous and consist of a narrow nucellus with a single integument whose innermost layer gives rise to an integumentary tapetum. Usually there is a single archesporial cell in the nucellus which directly functions as the megaspore mother cell without cutting off a wall cell. Sometimes more than one archesporial cell have been recorded. A list of such genera has already been compiled by Schnarf (1931).

Megaspore formation and Embryo sac.—The megaspore mother cell divides to form a tetrad of four megaspores of which normally the chalazal
produces the embryo sac; but in the tribes Astereae, Cichorieae and Senecionae either the micropylar or the chalazal megaspore has been found to function, and in the tribe Calenduleae it is the micropylar megaspore which usually forms the embryo sac. Sometimes more than one megaspore mother cell go through the reduction divisions and as a result several embryo sacs arise in the same nucellus, as recorded for several species of *Chrysanthemum* (Tateishi, 1929). Palm (1914a) has recorded an important case in *Pyrethrum parthenifolium* var. *aureum* which has a sixteen-nucleate embryo sac of the Peperomia-type and the same type has also been found in *Erigeron dubius* (Tahara,* 1921), *E. politus* and *E. eriocephalus* (Holmgren,* 1919). In *Erigeron alpinus*, Chiarugi (1927a) found that the embryo sac is sometimes of the Peperomia-type and sometimes of the Scilla-type. In *Tanacetum vulgare* (Palm, 1914a) twelve-, fourteen- and sixteen-nucleate embryo sacs are known to be formed, so it is regarded as a transitional form from the Scilla-type to the Peperomia-type. Ward* (1880) found the Lilium-type of embryo sac development in *Pyrethrum balsaminatum*, but this work is very old and needs confirmation. Palm* (1922) observed the Scilla-type of embryo sac formation in *Vittadinia triloba*. Holmgren* (1919) found the same in *Erigeron unalaschkensis* and *E. coulteri*. In *Erigeron glabellus*, Carano* (1921) found that the embryo sac is mostly of the Scilla-type but rarely it is of the normal-type and in *Erigeron karwinskianus* var. *mucronatus* there is a great deal of variation; three types—the Normal, Scilla and Lilium—have been found to be present (Carano,* 1921). Chamberlain (1895) and Oppermann (1904) studied Aster *novae-angliae* and described a rather peculiar case where a nucleus from the antipodal region became an egg cell.

**Antipodals.**—The antipodal cells are usually situated one above the other in a row. Very often the originally three antipodal cells increase in number as in *Gnaphalium, Antennaria, Conyza, Tussilago* (quoted in Schnarf, 1927), *Senecio* (Mottier, 1893), and *Aster* (Chamberlain, 1895; Oppermann, 1904). Sometimes from the very beginning there are only two antipodal cells as in *Zinnia grandiflora* (Palm, 1931), *Bidens leucanthus*, *B. tripartitus*, *Xanthium spinosum* (Dahlgren, 1920), *Cosmos bipinnatus*, *Cosmidium burridgeanum* (Täckholm, 1916), *Sanvitalia verbesina* (Hegelmaier,* 1889) and *Helianthus annuus* (Dahlgren, 1924).

Increase in the number of nuclei in each antipodal cell is a very common feature in the family. Täckholm (1916) reported as many as forty nuclei in an antipodal cell of *Cosmidium burridgeanum*.

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* All the authors marked with an asterisk are quoted in Schnarf, 1927.
Antipodal haustoria.—Miss Goldfuss* (1898) studied Leucanthemum lacustre and observed that the chalazal antipodal cell increases in size and forms a haustorium; she also noted a similar condition in Helianthus maximilianus and Chrysanthemum leucanthemum. Chamberlain (1895) studied Aster nova-anglia and found that the originally three antipodal cells increase in number forming a row of cells sometimes as many as twenty. This antipodal tissue extends into the basal part of the ovule and functions as the haustorium. Miss Oppermann (1904) also reported the presence of a similar haustorium in Aster undulatus. Further it seems to have become generally accepted that in the tribe Asteræ the antipodal cells persist and develop a chalazal haustorium. Palm (1914b) also studied Aster nova-anglia and to the haustorial structure present in it gave a new interpretation. He concluded that when one of the megaspores other than the chalazal one develops into the embryo sac the deeper megaspores persist, enlarge and form the haustorium. According to him in Solidago serotina the micropylar megaspore is always the functional one and the others form a haustorium. Chamberlain (1918) pointed out that the figures given by Palm to support his view are not convincing and reasserted his opinion that the haustorium in Aster and Solidago is of antipodal origin. In Grindelia squarrosa (Howe, 1926), there are two antipodal cells which persist but do not divide. One or both of them grow laterally into the integument thus forming one or two lateral haustoria which may extend nearly to the surface of the ovule.

Synergids.—In some cases synergids with hooks have been found. Dahlgren (1928) has already given a list of such genera of the family and they are as follows:—

Achillea clavens, Adenostyles albifrons, Anthemis alpina, Artemisia nitida, Bellidiastrum michelii, Chrysanthemum alpinum and Helianthus annuus.

Synergid haustoria.—Synergid haustoria have also been observed in a few plants in the family. Hegelmaier* (1889) studied Helianthus and found that the slender upper end of the synergid projects out into the micropyle and functions as a haustorium. In 1920 Dahlgren studied several species of Calendula and reported that the haustoria are formed from the synergids. In 1924 he examined Ursinia anthemidoides and found that the synergids elongate very much and come to resemble the pollen tube; the elongated ends extend into the micropyle and from them or perhaps from one of them originates a haustorium. Schürhoff* in 1926 confirmed the presence of synergid haustoria in Ursinia anthemidoides and Calendula officinalis.
Double fertilisation.—Double fertilisation has been reported in several plants of the family. Schnarf (1931) has already given a list of such plants and as far as I know no additions have been made since then.

Endosperm.—Both cellular and nuclear types of endosperm are found in the family. The former is found in Xanthium, Galinsoga, Bidens, Tagetes and Silphium, etc., and the latter is found in Dahlia, Helianthus, Grindelia, Ursinia, Dimorphotheca, Cirsium, Arctium and Centaurea, etc. When the endosperm is cellular, the direction of the first wall is not constant. In several members of the family it is transverse, in others it is longitudinal and in still others it is oblique. This may sometimes occur in the same genus and even the same species (Dahlgren, 1920).

Embryo.—The development of the embryo shows nothing peculiar. The fertilised egg divides by means of a transverse wall into a basal cell and an apical cell. By further divisions in the apical cell a mass of cells is formed which gives rise to the cotyledonary part. The remaining portion of the embryo as well as the suspensor is formed by transverse divisions in the basal cell.

Diploid parthenogenesis.—Diploid parthenogenesis is found in several plants of the family. Rosenberg (1930) has already given a comprehensive account of this and classified it under the following three types:—

1. The ‘Antennaria-type’ in which the megaspore mother cell directly gives rise to the embryo sac as in Erigeron annuus (Holmgren,** 1919), E. karwinskianus (Carano**, 1919-1927), Antennaria alpina (Juel,** 1900), Hieracium and subgenus Eu-Hieracium (Rosenberg,** 1906, 1908).

2. The ‘Taraxacum-type’ in which the megaspore mother cell divides into two cells of which one produces the embryo sac as in Taraxacum (Sears, 1922) and Chondrilla juncea (Rosenberg, 1912).

3. The ‘Alchemilla-type’ in which four cells are produced from the megaspore mother cell and one of these gives rise to the embryo sac as in Artemisia nitida (Chiarugi,** 1926).

All these three types are found in the family Compositae and the gametophytes are of normal structure, though the nuclei are diploid.

Apospory.—In Hieracium excellens and H. flagellare, Rosenberg (1907) observed the formation of a normally appearing but diploid female gametophyte from a cell of the nucellus lying just below the normal tetrad of

** For these papers the reader is referred to the bibliography given by Rosenberg, 1930.
megaspores. In *Hieracium aurantiacum* he found that the embryo sac is nearly always of aposporic origin, and its origin is most commonly from an epidermal cell of the nucellus which encroaches on the tetrad. In *Artemisia nitida* (Chiarugi,** 1926) the aposporic embryo sac arises from a cell of the epidermis.

*Polyembryony.*—Both ‘false’ and ‘true’ polyembryony are found in the family. The former type is represented in *Taraxacum officinale* (Schwere,* 1896) in which there are several mother cells producing a number of embryo sacs each giving rise to an embryo. The latter type is known to occur in species of the genus *Hieracium* (Rosenberg, 1907; Schnarf,** 1919; Haberlandt,** 1921), the extra embryo being produced from the antipodal cells, or the synergids, or even the endosperm cells. In *Taraxacum officinale* (Schwere,* 1896) sometimes one of the synergids also develops into an embryo.


The material was collected from various localities at Agra. Some imbedded material and slides were very kindly passed on to me by Dr. P. Maheshwari to whom I am indebted for them. A few of these were prepared by Mr. A. K. Mitra of the University of Allahabad. After removing the involucre of bracts the heads were trimmed on opposite sides to secure easy penetration. Formalin-acetic-alcohol, Chrom-acetic acid (chromic acid 1 gm., acetic acid 3 c.c. and water 100 c.c.), Nawaschin's fluid and hot corrosive sublimate-formalin-acetic acid-alcohol were used for fixing. The last-mentioned fixative gave the best results. The subsequent processes of dehydration and infiltration were as usual. Sections were cut 5-12 microns thick and stained in Heidenhain's Iron-alum Haematoxylin. The differentiation was carried out in an aqueous solution of picric acid which gave very satisfactory results.

3. Investigation.

*Flower.*—The flowers are arranged in heads which are 1/4 to 1/3 inch in diameter and borne on stiff peduncles. The ray florets are carpellate and the disc florets are hermaphrodite.

As regards the development of the floral parts the first structures to appear are the petals which look like small papillae (Fig. 1) but in their further development they assume a tube-like form and the tips curve inwards, thus furnishing an efficient protection to the stamens and the pistil. The upper margin of the tube has four or five projecting teeth.
Almost immediately following the corolla appear the primordia of the stamens (Fig. 2) which are usually four but sometimes five in number. Soon after, the two scale-like sepals make their appearance. The last of the floral organs are the two carpels which appear as outgrowths of cells on the inner side of the staminal ring (Fig. 3). By elongation and union of these is formed the style which over-arches a flask-shaped cavity below, in which develops the ovule. Fig. 4 shows the development of a ray floret with the developing petals, sepals and the carpels.

**Microsporogenesis.**—The anther is at first a mass of homogeneous cells which becomes four-lobed in cross section. The archesporial cells are rather late in differentiation and cannot be clearly distinguished from the other cells of the anther till a parietal cell has been formed on the outside (Fig. 5). The primary wall cell by further anticlinal and periclinal divisions gives rise to three layers—the endothecium, a middle layer and the tapetum. The tapetal layer consists of large uninucleate cells in the beginning (Fig. 6), but later they become binucleate and show densely granular contents (Fig. 7). Sometimes four to five nuclei have been found in a single tapetal cell. The nuclear divisions are mitotic and occur at the time when the microspore mother cells are in syngnathesis. The shape of some of the nuclei in the tapetal cells suggests that either there is a frequent fusion of nuclei or amitotic divisions also occur in later stages.

Meanwhile the row of primary sporogenous cells also divides to form two rows of microspore mother cells which are densely protoplasmic and have large nuclei with one or two prominent nucleoli. After syngnathesis they begin to round up and as soon as the first reduction division is over the two daughter nuclei enter the second reduction division, no wall being formed between them. Walls are laid down only after the second division is over. It was found that the two outer loculi in an anther are in a slightly more advanced stage of development than the inner ones. A similar condition has also been noted by Merrell (1900) for Silphium.

After the reduction divisions are over, the first evidence of further development in the pollen mother cell is the beginning of constrictions of the cytoplasm at four points placed at equal intervals on its periphery. The constrictions of the cytoplasm become progressively deeper until they meet in the centre and finally cut up the cytoplasm into four masses.
Both tetrahedral and isobilateral types of microspore tetrads are found (Figs. 11 and 12). During the time the mother cells are undergoing the reduction divisions, the tapetal cells gradually lose their original shape, their walls begin to disappear and their nuclei take a slightly deeper stain. Fig. 8 shows a stage when the young pollen grains are beginning to round up, the middle layer has degenerated and the tapetal cells have become continuous. Their cytoplasm begins to penetrate inwards (Fig. 9) and surrounds the microspores, carrying with it the tapetal nuclei. Finally each pollen grain is surrounded by the cytoplasm and the irregularly scattered nuclei of the tapetum (Fig. 10).

Later the periplasmodium gradually diminishes in amount and the tapetal nuclei undergo a progressive degeneration till they finally disappear. At the time when the pollen grains are mature no trace of the periplasmodium can be seen. That the periplasmodium may serve to nourish the pollen grains, seems to be indicated by the fact that as the pollen grains go on increasing in size, the periplasmodium goes on decreasing in amount. A similar behaviour of the tapetal cells has also been observed in Silphium by Merrell (1900). Dahlgren (1920) observed the presence of a true periplasmodium in Tagetes signatus. Both Juel* (1915) and Tischler (1915) working independently on Silphium laciniatum observed that the tapetal cells get in between the pollen grains but they do not fuse completely.

The microspores very early develop a thick exine which is beset with a number of spines and the intine also becomes thick, as can be seen in Figs. 9, 10, 14 and 15. A similar intine has also been sketched by Tischler (1915) for Silphium laciniatum. On division of the microspore nucleus a large tube cell and a small crescent-shaped generative cell are formed (Fig. 14). Later the nucleus of the generative cell divides and two male cells are formed (Fig. 10). At this stage practically no structure can be made out in the male nuclei. Fig. 15 shows a peculiar dumb-bell-shaped pollen grain with three nuclei at one end. This seems to be a double pollen grain wherein after the tetrad formation the two microspores have not separated. In Podostemon subulatus also, Magnus* (1913) found double pollen grains and in Calycanthus fertilis, Schührhoff (1922) found double, triple and quadruple pollen grains. Recently, Gustafson (1933) has also found double, triple and quadruple pollen grains in Hieracium flagellare. Merrell (1900) reported that in Silphium the pollen grains germinate in anthers and the male nuclei are elongated and spiral. The pollen grains in Eclipta erecta have three germ pores which is the usual condition in the family Compositae.

Several attempts were made to germinate the pollen grains in sugar solutions but they were unsuccessful.
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Pope (1925), working on the pollen morphology of about 80 families represented in the flora of Colorado, mentioned that the pollen grains in the family Compositae are ellipsoidal. In Eclipta erecta I find that the mature pollen grains are spherical and about 16 microns in diameter. They are light yellow in colour and have an echinate surface. Further, for the sake of comparison I also examined the mature pollen grains of Tagetes and Dimorphotheca and in these also I found the pollen grains to be spherical and not ellipsoidal. In all the cases mentioned above the pollen grains were studied by the same methods as suggested by Pope.

Occasionally some of the pollen grains degenerate. Fig. 13 shows a tetrad where two of the microspores are degenerating. Several cases of older pollen grains in the process of degeneration were also seen.

Megasporogenesis.—A short time before the floral organs attain their maximum length, a small protuberance appears at the bottom of the ovarian cavity; this is the young ovule. At first it consists of a mass of cells which are all alike, but soon a hypodermal archesporial cell becomes differentiated from the adjoining cells by its size and staining reactions (Fig. 16). At this stage the nucellus is straight but by further growth the ovule becomes completely anatropous. No wall cell is cut off and the primary archesporial cell enlarges and directly functions as the megaspore mother cell. Fig. 17 shows a nucellus with a megaspore mother cell and the single integument. On reduction a linear tetrad of four megaspores is produced (Fig. 18). The nucellus is long and cylindrical but is very much reduced so that there is only a single cell layer round the megaspores.

The lowest megaspore functions and the others quickly degenerate (Fig. 19). This enlarges and develops two vacuoles one on either side of the nucleus. About the same time when the nucleus of the functioning megaspore divides to form the two-nucleate embryo sac, the single layer of nucellar cells begins to degenerate (Figs. 20 and 21) and by the time the four-nucleate stage is reached (Fig. 22) no trace of it can be made out and the embryo sac comes to lie directly within the jacket formed by the innermost layer of cells of the integument which become richly protoplasmic and elongated in the radial direction. After the four-nucleate stage the embryo sac elongates very much. The mature embryo sac is eight-nucleate and shows the usual structure typical of the angiosperms. The egg is a pear-shaped structure and the nucleus lies at the bottom in a dense mass of cytoplasm. In the upper portion there is a large vacuole occupying nearly two-thirds of the egg. The two synergids lie one on either side of the egg. They are densely filled with protoplasm at the micropylar end, and each has a large vacuole
at its lower end. The three nuclei at the lower end of the embryo sac organise to form the antipodal cells which will be discussed later on. The remaining two nuclei are the polar nuclei which meet in the middle of the embryo sac (Fig. 23). They fuse before fertilisation and the fusion nucleus moves upwards and comes to lie near the egg (Fig. 24). The mature embryo sac is broader in the middle and forms a slender elongated pouch-like structure in the chalazal region.

To start with, there are usually three uninucleate antipodal cells arranged in a linear row. The nuclei may divide in any of the three cells or in all of them and the divisions are not followed by wall formation (Fig. 27). A similar condition has also been reported in Dahlia variabilis (Goldflus, 1898) and Tagetes signatus (Goldflus, 1898; Dahlgren, 1920).

In some cases only two antipodal cells are formed of which the lower is uninucleate and the upper contains two nuclei (Fig. 24). The nuclei of both these cells may divide but here, too, there is no wall formation (Figs. 25 and 26). Thus only two antipodal cells containing a large number of nuclei are formed. A similar condition has been noted in several other genera also in this tribe (Helianthoideae), viz., Bidens leucanthus (Dahlgren, 1920), Cosmos bipinnatus and Cosmidium burridgeanum (Täckholm, 1916), Helianthus annuus (Täckholm, 1916; Dahlgren, 1924), Zinnia grandiflora (Palm, 1931), Xanthium spinosum and Bidens tripartitus (Dahlgren, 1920). Palm (1931) studied Zinnia and reported that in most cases the two nuclei in the upper antipodal cell move to the centre of the cell where they fuse; relatively rare is the occurrence of four nuclei in this cell; when four nuclei have arisen, fusion between two of the nuclei may take place. Quite rarely the four nuclei remain separate. Nuclear fusions are said to be a more or less regular feature in the giant antipodal cells of Cosmidium (Täckholm, 1916). In Eclípía I have not been able to find nuclear fusion in any of the cells though several cases of the upper antipodal cell with four nuclei (Fig. 26) were observed. By the division in the two-celled antipodal region a large number of nuclei are known to be formed in Bidens leucanthus (Dahlgren, 1920), Cosmos bipinnatus and Cosmidium burridgeanum (Täckholm, 1916).

Degenerations in the ovary have been observed in a number of cases. Fig. 23 shows an embryo sac in which the egg and the two synergids are degenerating, though the remaining nuclei are yet comparatively healthy.

Pollen tubes enter by way of the micropyle. Actual double fertilisation was not seen but the presence of a pollen tube (Fig. 28) in all embryo sacs with young embryos is suggestive of its occurrence.
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Endosperm and Embryo — The primary endosperm nucleus divides before the fertilised egg. The first wall is transverse and the endosperm is cellular from the beginning, as in Tagetes signatus, Bidens trispartitus, Galinsoga parvisflora, Xanthium spinosum and Silphium laciniatum (Dahlgren, 1920).

The first division wall in the oospore is transverse (Fig. 28) as usual and separates a large proximal vesicular cell from a smaller terminal cell. Due to more rapid divisions in the endosperm this is already a several-celled tissue at this stage. After a three-celled proembryo is formed, the next division takes place in the terminal cell which divides by a vertical wall (Fig. 29). By further divisions the lower region of embryo becomes globular (Fig. 32) and a dermatogen is marked out. Later stages were not present in my preparations.

4. Summary.

1. The floral parts develop in the following succession:—petals, stamens, sepals and carpels.

2. The divisions of the microspore mother cells are simultaneous. The microspores may be arranged tetrahedrally or isobilaterally. The tapetal cells form a periplasmodium. The pollen grains are trinucleate at the time of shedding and each of them has three germ pores.

3. There is a single massive integument whose innermost layer forms an integumentary jacket surrounding the embryo sac.

4. In the nucellus there is a single hypodermal archesporial cell which functions directly as the megaspore mother cell.

5. The first and second divisions of the megaspore mother cell are followed by wall formation and a linear tetrad of four megaspores is formed of which the chalazal megaspore functions.

6. The mature embryo sac is of the normal eight-nucleate type. The number of antipodal cells varies from two to three. When there are two antipodal cells the upper one contains two nuclei. The nuclei of the antipodal cells divide and the cells often become multinucleate.

7. The endosperm nucleus divides prior to the division of the egg nucleus and the division is followed by wall formation.

8. The first division of the fertilised egg is by a transverse wall. There is a short suspensor.

In the end I regard it my pleasant duty to express my sincere thanks to Dr. P. Maheshwari for his valuable suggestions and keen interest during the course of the investigation. I am also indebted to Principal F. J. Fielden of the Agra College for having helped me in the translation of some difficult German passages.
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EXPLANATION OF FIGURES.

Figs. 1-4.—Development of the flower: Fig. 1. Appearance of petals; Fig. 2. Appearance of stamens; Fig. 3. Development of sepals and carpel; Fig. 4. A ray floret showing the developing petals, sepals and carpels. × 189.

Fig. 5.—Part of transverse section of a young anther showing an archesporial cell divided into primary wall cell and primary sporogenous cell. × 900.

Fig. 6.—Transverse section of an anther showing three wall layers, the innermost is the uninucleate tapetum; and spore mother cells. × 900.

Fig. 7.—Longitudinal section of an anther lobe showing the binucleate tapetum and the spore mother cells in the prophase of reduction division. × 900.

Fig. 8.—Longitudinal section of an anther lobe showing the degenerated middle layer, the beginning of tapetal plasmidium and the just rounded up microspores. × 900.

Fig. 9.—Same, with well-developed tapetal plasmidium entering in between the uninucleate pollen grains which have got a well-developed exine beset with spines and a thick intine. × 900.

Fig. 10.—Same, the tapetal plasmidium has surrounded the pollen grains which are mostly binucleate. In one of the pollen grains the generative nucleus has divided to form two spindle-shaped male cells. × 900.

Fig. 11.—Tetrahedral tetrad of microspores. × 900.

Fig. 12.—Isobilateral tetrad of microspores. × 900.

Fig. 13.—Tetrahedral tetrad of microspores with two degenerating microspores. × 900.

Fig. 14.—A pollen grain showing the crescent-shaped generative cell and the tube nucleus. × 900.

Fig. 15.—A double pollen grain with three nuclei. × 900.

Fig. 16.—Longitudinal section of the nucellus showing the hypodermal archesporial cell. × 945.
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Fig. 17.—Megaspore mother cell and the single integument. × 945.
Fig. 18.—Tetrad of megaspores, the upper three are degenerating. × 945.
Fig. 19.—Functioning megaspore and the three degenerated megaspores. × 945.
Fig. 20.—Two-nucleate embryo sac. × 945.
Fig. 21.—Two-nucleate embryo sac, the two nuclei are at the two poles; the integumentary jacket and the remains of the nucellar tissue. × 945.
Fig. 22.—Four-nucleate embryo sac. × 945.
Fig. 23.—Mature embryo sac showing three uninucleate antipodal cells. × 945.
Fig. 24.—Mature embryo sac with two antipodal cells, the upper antipodal cell has two nuclei. × 945.
Fig. 25.—Antipodal region of an embryo sac showing two binucleate antipodal cells. × 945.
Fig. 26.—Same, showing two antipodal cells, the lower cell is binucleate and the upper one has four nuclei. × 945.
Fig. 27.—Same, with three antipodal cells, the lower cell has four, the middle one has two and the upper one has five nuclei. × 945.
Fig. 28.—Longitudinal section of the ovule showing a two-celled embryo, cellular endosperm and the remains of the pollen tube. × 720.
Fig. 29.—A four-celled embryo. × 720.
Figs. 30-32.—Stages in the development of the embryo. × 720.