Mukerji and Dasgupta (1954) have also described the female genitalia of *Cyclopodia sykesi* (Nycteribiidae).

The flies were collected from cattle and horses at Indore. For external genitalia the abdomen is boiled in 10% KOH for transparency, material washed and neutrilised with Acetic Acid. After dehydration, slides were mounted in Canada balsam. Temporary mounts in Berlese fluid gave better results.

The female external genitalia of *H. maculata* are reduced as in other Pupipara. These are represented by two genital plates, one dorsal (DP) and another ventral (VP) (Fig. 1). Both plates are hidden under

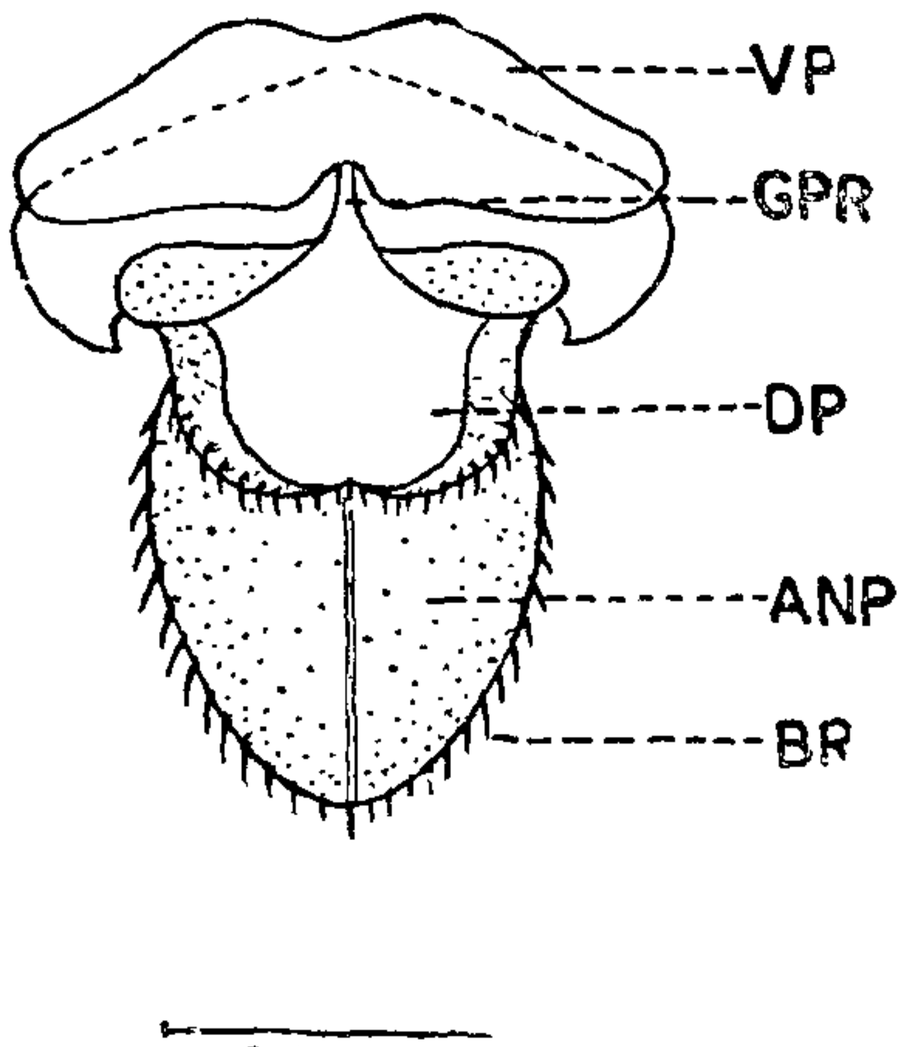


FIG. 1. External genitalia of female *Hippobosca maculata* in ventral view ANP—anal plate; BR—bristles; DP—dorsal plate; GPR—gonopore; VP—ventral plate.

a large dorsally placed horse-shoe shaped analplate (ANP), beset with numerous setae. Thus the genital plates are not visible from dorsal side. They can be seen by removing the anal plate. The presence of genital plates is also reported by Theodar (1953) in *Nycteribiia, Penicillidia* and *Eucampsipoda* (Nycteribiidae).

The dorsal plate is larger than the ventral plate. The differentiation can be seen from the ventral view of the abdomen. Anteriorly the dorsal plate is convex while posteriorly notched or concave and bears numerous setae. The ventral plate is small and chitinised, divisible into two similar wing-shaped halves. Both the plates are connected by a thin pleural membrane and guard the female gonopore (GPR). The dorsal plate is not attached to the anal plate as reported by Theodar (1953) in *Eucampsipoda*.

I am highly thankful to Dr. Ravi Prakash, Head, Department of Life Sciences, University of Indore, and now Vice-Chancellor, University of Bhopal, for guiding and providing facilities during the present work.

Department of Zoology, S. N. PARMAR.
P.M.B. Gujrati Science College,
Indore (M.P.), *November* 23, 1973.

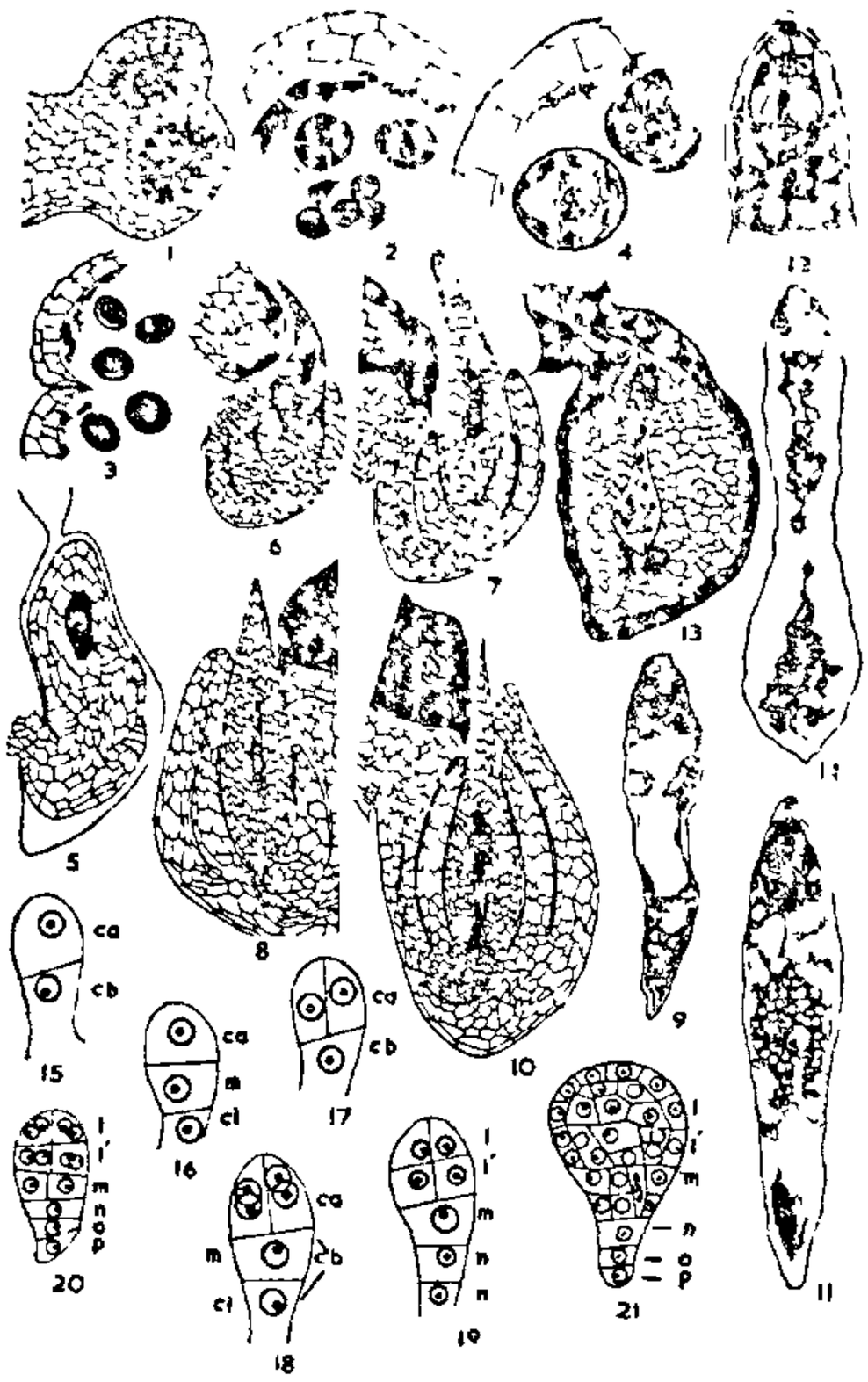
1. Austen, E. E., *British Museum*, London, 1909, 15, 1.
2. Mukerji, D. and Dasgupta, B., *Proc. Zool. Soc.*, Calcutta, 1954, 7, 1, 15 Figs.
3. Theodar, O., *Trans. 9th Int. Congr. Ent.*, Amsterdam, 1953, 2, 27, 6 Figs.

SOME EMBRYOLOGICAL FEATURES OF *EUPHORBIA VERMICULATA* RAF.

SPECIES of the genus *Euphorbia*, besides displaying extreme morphological diversity, show features of utmost embryological interest. As far as is known, the occurrence of as many as four types of embryo sac development, namely, Polygonum, Peperomia, Allium and Fritillaria, seem to be an outstanding feature of *Euphoria*[1,3–6], since all other genera of the Euphorbiaceae investigated so far are reported to show one or the other of the types of embryo sac development. To date, our embryological knowledge of *Euphorbia* is restricted to very few species. The following contribution presents, from work in progress, the more important embryological features of *Euphorbia vermiculata* Raf.

The anther is tetrasporangiate. An anther lobe at microspore mother cell stage comprises the epidermis, endothecium, a single middle layer and the secretory tapetum (Fig. 1). The development of the anther wall corresponds to the dicotyledonous type[2]. The tapetal cells remain uninucleate throughout and start degenerating *in situ* about the time the microspore tetrads are formed (Fig. 2). The fibrous thickenings are laid down in the endothecial cells at the one-celled stage of the pollen grains (Fig. 3) and they remain feeble even after anthesis. The microspore mother cells undergo the regular meiotic divisions of the simultaneous type resulting mostly in tetrahedral tetrads (Fig. 2). The spheroidal tricolpate pollen grains are shed at the 2-celled stage (Fig. 4). The exine of the pollen grain is sharply differentiated into an outer thick sexine bearing minute but dense echinulations and a ridged nexine (Fig. 4).

The ovary is superior, tricarpellary, syncarpous and trilocular with a single anatropous, bitegminal and crassinucellar pendulous ovule in each locule borne on axile placentae. The integumentary



FIGS. 1–21. Fig. 1. T.s. Anther lobes at microspore mother cell stage showing a four-layered wall. Note 1-nucleated tapetal cells, × 180. Fig. 2. T.s. A portion of the anther lobe to show epidermis, endothecium, degenerated middle layer, disorganising tapetum and tetrahedral tetrads, × 180. Fig. 3. T.s. A portion of the anther lobe to show the feebly developed fibrous thickenings in endothecial cells at 1-celled stage of the pollen grains, × 180. Fig. 4. T.s. A portion of the anther lobe showing 2-celled pollen grains. Note the fibrous thickenings remaining feeble even at the 2-celled stage of the pollen grains. × 180. Fig. 5. L.s. Ovule primordium showing the initiation of the integumentary primordia. Note the megaspore mother cell in the nucellus, × 300. Fig. 6. L.s. Anatropous ovule at megaspore mother cell stage. Note the outer integument outgrowing the inner, nucellar beak, deep seated megaspore mother cell and placental obturator, × 180. Fig. 7. L.s. Ovule to show a linear tetrad of megaspores and growing placental obturator, × 180. Fig. 8. L.s. Ovule showing 2-nucleate embryo sac and degenerated megaspores, × 180. Fig. 9. Embryo sac with eight nuclei. × 300. Fig. 10. L.s. Ovule showing organised embryo sac, × 450. Fig. 11. Organised embryo sac. Note the starch grains, × 450. Fig. 12. Micropylar part of the embryo sac showing egg apparatus and the two polar nuclei at the vicinity of the egg at fertilisation, × 600. Fig. 13. L.s. Developing seed to show the globular embryo, disorganising nucellar beak, cellular

primordia appear at the megaspore mother cell stage (Fig. 5) and their further growth seems to be rather delayed. The inner integument is the first to differentiate (Fig. 5), but the outer subsequently outgrows the inner (Figs. 6, 7, 8). The nucellus is massive and projects far beyond the micropyle as a prominant nucellar beak (Figs. 6, 7, 8, 10). The placental obturator differentiates very early, but attains its maximum development at the 8-nucleate stage of embryo sac (Fig. 10) and shows signs of disorganisation after fertilisation (Fig. 13). At the chalazal region, below the embryo sac, a pad of tissue consisting of richly cytoplasmic and uninucleate cells is discernible at about 8-nucleate stage of the embryo sac (Fig. 10) and becomes more and more prominent in the ovule after fertilisation (Fig. 13).

The megaspore mother cell, which is deep seated in the nucellus (Fig. 6) undergoes the customary meiotic divisions to develop a linear tetrad of megaspores (Fig. 7). The chalazal megaspore functions (Fig. 8) and its nucleus undergoes the three successive mitotic divisions leading to the formation of four nuclei at each of the proximal and distal ends of the embryo sac (Fig. 9). The eight nuclei organise in a manner distinctive to the polygonum type of development (Figs. 10, 11). The polar nuclei fuse in the vicinity of the egg (Fig. 12) and form the secondary nucleus. The three antipodal cells degenerate even before the fusion of the polar nuclei (Figs. 10, 11). The cytoplasm at the central region of the embryo sac is richly studded with starch grains (Fig. 11).

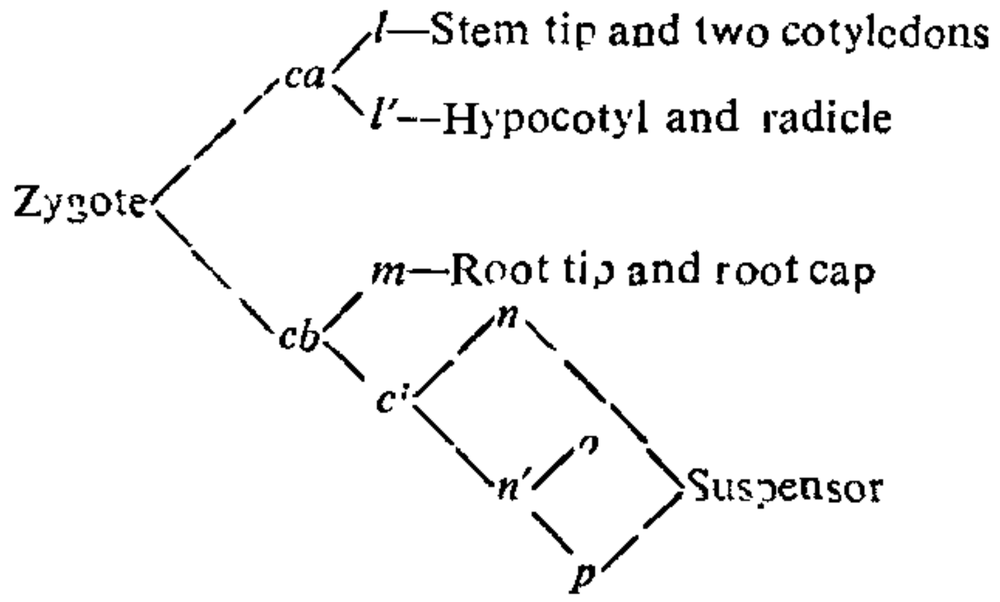
The development of the endosperm is Nuclear. Endosperm formation begins long before the first division of the zygote and at the 2-celled stage of the pro-embryo twenty free nuclei are noted in the embryo sac (Fig. 14). The nuclei of the developing endosperm show accumulation around the embryo and at the antipodal end, while they are relatively few at the sides. When the embryo is at globular stage, cell wall formation commences from the micropylar end and proceeds toward the antipodal end (Fig. 13).

The embryo development follows the Euphorbia variation of the Onagrad type. The division of the zygote occurs invariably after that of the primary endosperm nucleus. The first division is tranverse engendering the terminal cell *ca* and basal cell *cb* (Figs. 14, 15). The basal cell then divides trans-

---

endosperm at the micropylar part of the embryo sac, well organised hypostase and the disorganising placental obturator, × 180. Fig. 14. Embryo sac with 2-celled proembryo and 20 free endosperm nuclei, × 300. Figs. 15–21. Different stages in the development of embryo, × 450.

versely to form *m* and *ci* either before or after the vertical division of the terminal cell (Figs. 16, 17, 18). A vertical wall in *ca* results in two juxtaposed cells, which divide again by another longitudinal wall at right angles to the preceding one resulting in a quadrant (Fig. 18). Subsequently each cell of the quadrant divide transversely forming an octant resulting in two tiers *l* and *l'* of four cells each (Figs. 19, 20). The upper four cells of the octant ultimately give rise to the stem tip and the two cotyledons, while the lower tier of cells functions to form the hypocotyl and radicle. The cell *m*, derived from *cb*, produces the root tip and root cap, while *n*, *o* and *p*, derived from *ci*, constitute a three-celled suspensor (Fig. 21). The scheme given hereunder summarises the origin of the different parts of the embryo from the cells of the proembryo :



Work on other exotic species of *Euphorbia* is in progress.

Grateful appreciation is hereby expressed to Professor T. Sreeramulu, for his constant encouragement. Thanks are also due to Professor C. J. Hillson, Pennsylvania, for sending the material and to the Council of Scientific and Industrial Research, New Delhi, for the award of Junior Research Fellowship to one of us (Miss K. R. R. Devi).

Department of Botany, Andhra University
P. S. Prakasa Rao.
K. Raja Rajeswari Devi.
Post-Graduate Centre,
Guntur, Andhra Pradesh,
January 21, 1974.

1. Banerji, I., *Proc. Ind. Acad. Sci.*, 1951, 34 B, 172.
2. Davis, G., *Systematic Embryology of Angiosperms*, New York.
3. Kajale, L. B. and Rao, G. V., *J. Ind. bot. Soc.*, 1943, 22, 229.
4. Maheshwari, P., *Proc. Ind. Acad. Sci.*, 1942, 15 B, 158.
5. — and Johri, B. M., *Beih. bot. Zol.*, 1941, 61 A, 125.
6. Rao, P. N., *Symposium on Comparative Embryology of Angiosperms*, 1970, No. 41, 136.
7. Thathachar, T., *J. Mysore Univ.*, 1953, 13 B, 43.

IS THE EMBRYO SAC OF PODOSTEMACEAE BISPORIC?

In spite of repeated investigations and varied interpretations put forward, the exact nature of the embryo sac development in Podostemaceae requires a proper explanation. Recently, Battaglia[1] has reviewed the previous literature on the embryo sac of Podostemaceae. He classifies the embryo sac development in this family under the following types : the Dicraea type, the Podostemum type and the Apinagia type. These types of embryo sac development have been accepted without any reservation by all embryologists, who have investigated Podostemaceae, as a reduced bisporic type[2-12].

Before discussing the types of embryo sac development in Podostemaceae, it is necessary to know the criterion employed in the classification of the types of embryo sacs in angiosperms. P. Maheshwari[13] classified the types of embryo sac development in angiosperms into the mono-, the bi-, and the tetrasporic types. Although these terminologies are in wide usage, there is confusion regarding their exact definition. Some authors regard merely the number of megaspores that contribute to the formation of the organised embryo sac as the criterion[14-15], while others consider only the number of megaspore nuclei that participate in the embryo sac organisation[16-17]. To avoid this confusion, it appears appropriate at this stage to recall the original definition put forward by P. Maheshwari (1937, p. 360) which reads thus ".... there is a general consensus of opinion about regarding the first four nuclei formed after the reduction divisions as equivalent to megaspore nuclei ; the laying down of a wall separating them is a matter of secondary importance. Consequently, an embryo sac formed from the divisions of a single megaspore nucleus should be called *monosporic* ; when two take part in its development, it is *bisporic* ; and when all four contribute to it, it is *tetrasporic*".

If the above definition is carefully examined, then the development of the embryo sac in Podostemaceae needs a critical reconsideration. The Dicraea type* and the Podostemum type must be considered as truly bisporic because in both cases two megaspore nuclei are involved in the subsequent divisions and therefore contribute nuclei to the organised embryo sac. The megaspore mother cell divides to form two dyad cells. The micropylar dyad cell degenerates while the chalazal dyad cell enlarges and divides to produce two megaspore nuclei which again divide to produce four nuclei which in turn take part in the organisation of the embryo sac. The difference between the Dicraea type and the Podostemum type lies in the organisation of the cells contributing to the mature embryo sac.