1. Bahadur, B., and Reddy, N. P., *New Phytol.*, 1975, **75**, 131.
2. — and Venkateshwarlu, T., *J. Indian Bot. Soc.*, 1976, **55**, 30.
3. — and — *Ibid.*, 1676 *b*, **55**, 81.
4. —, Rao, K. L. and Rao, M. M., *Curr. Sci.*, 1978, **47**, 584.
5. —, —, Vijaya Kumar, P., Reddy, N. P. and Rao, M. M., In: *Vistas in Molecular, Solid State and Biophysics*, (Prof. P. G. Puranik 60th Birth Day Commemoration Volume), Hyderabad, 1978.
6. Davis, T. A. and Ramanujacharyulu, T., *Sankhya, Indian J. Stat.*, 1971, **33**, 259.
7. —, *Proc. Indian Natl. Sci. Acad.*, 1974, **40**, 424.
8. — and Ghosh, S. S., *Adansonia*, 1976, **15**, 471.
9. Ghosh, S. S. and Davis, T. A., *Experientia*, 1978, **34**, 348.
10. Gunn, C. R. and Kluve, J., *Taxon*, 1976, **25**, 563.
11. Hutchinson, J., *The Genera of Flowering Plants*, (Angiospermae), Dicotyledons, Oxford University Press, London, 1964, **1**,
12. Smartt, J., *Tropical Pulses*, Longmans, London, 1976.

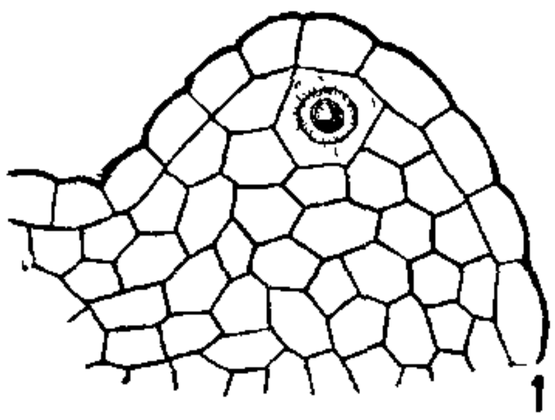
A CONTRIBUTION TO THE EMBRYOLOGY OF *SANSEVIERIA ZEYLANICA* WILLD.

Sansevieria, a member of the family Haemodoraceae (Bentham and Hooker[1]) is of considerable taxonomic interest eversince the placement of this in Agavaceae by Hutchinson[2]. Since the genus is embryologically unknown, the author has made an embryological study of one of its available species and used the same for the assessment of the systematic position of the genus.

The primary archesporium in the anther is a row of subhypodermal cells (Figs. 1 and 2). Soon after differentiation the primary archesporial cells undergo periclinal divisions to form a layer of sporogenous cells inwards and a layer of primary parietal cells outwards. The primary parietal layer divides anticlinally and periclinally producing 3 wall layers beneath the epidermis (Figs. 3 and 4). The innermost wall layer forms the secretory tapetum and the outermost wall layer forms the endothecium with fibrous thickenings (Fig. 5). The tapetal nuclei divide mitotically and the cells become bi-nucleate by the time the nuclei of pollen mother cells are in the prophase of first mitotic division. The two nuclei are closely adpressed to each other. The mature tapetal cells become vacuolated. As the anther matures, the growth of the pollen mother cells and the tapetum crushes the wall layers between the endothecium and the tapetum. With further growth of the anther the epidermis becomes very much stretched. The divisions of the microspore mother cells are successive and the microspore tetrads are isobilateral (Fig. 6). The pollen grains are shed at the two-celled stage and their exine is finely granular.

Ovules are anatropous, bitegmic and tenuinucellate. A single hypodermal archesporial cell differentiates in the nucellus before the initiation of integumentary primorida (Fig. 7). The archesporial cell can be recognised by its larger size, bigger nucleus and denser cytoplasm (Fig. 8). It enlarges and functions as the megaspore mother cell directly without cutting off a parietal cell. The megaspore mother cell undergoes two meiotic divisions and usually forms a linear or a T-shaped tetrad of megaspores (Figs. 9 and 10). Of the four, only the chalazal one is functional and the other three degenerate (Fig. 11). Three successive free nuclear divisions in the functional megaspore follow resulting in a monosporic eight-nucleate embryo sac (Figs. 11, 12 and 13) of the polygonum type. The eight nuclei organize themselves into a three-celled egg apparatus (Fig. 14), three antipodal cells and two polar nuclei which fuse near the chalazal region of the embryo sac to form a secondary nucleus. A prominent hypostase is present (Fig. 15). Embryo development could not be followed due to the formation of a clear abscission layer in the middle of the pedicel which results in the withering and falling off of flowers.

Bentham and Hooker placed *Sansevieria* along with *Ophiopogon* in the tribe Ophiopogoneae of the family Haemodoraceae. Engler and Prantl grouped both the genera in Liliaceae under the subfamily Dracaenoideae. Hutchinson deviated altoghether from the two classifications and transferred *Dracaena* and *Sansevieria* to the family Agavaceae. Embryological evidence indicates that *Sansevierai* differs considerably from the other members of Agavaceae in having a row of hypodermal cells as archesporium, and three wall layers (10–12 layers in Agave) in the anther, tenuinucellate ovules (crassinucellate in *Agave* and *Doryanthes*), absence of a parietal cell, absence of the placement of antipodals one above the other and absence of tubular projection in the embryo sac. In view of the above facts, the transfer of this genus to Agavaceae as done by Hutchinson seems to be unnecessary and this conclusion is also supported by cytological studies (Sharma and Chaudhuri[4] and Lakshmi[3]). An embryological study of related genera in Haemodoraceae and Liliaceae may throw further light on the current systematic position of the genus.



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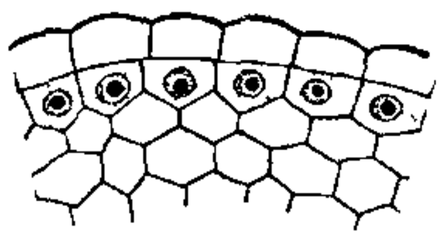

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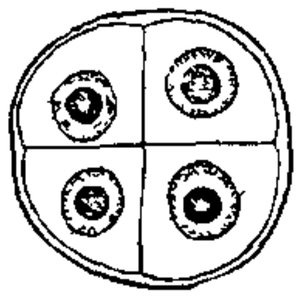

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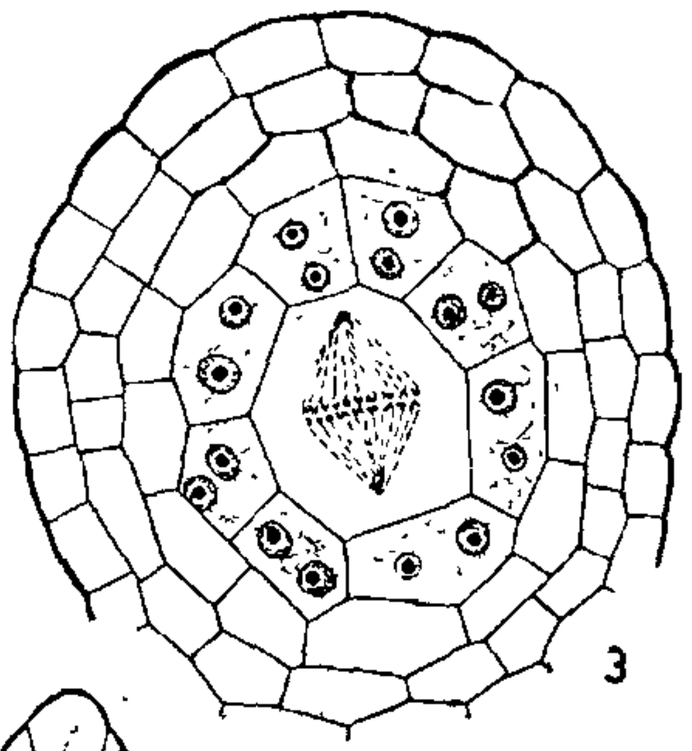

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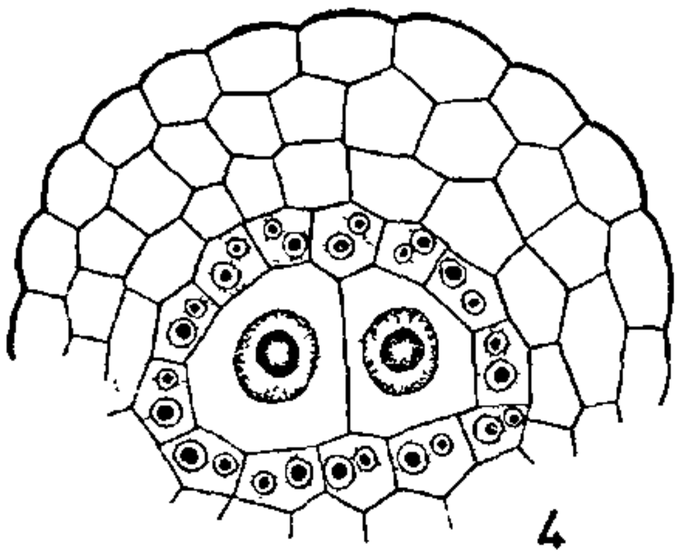

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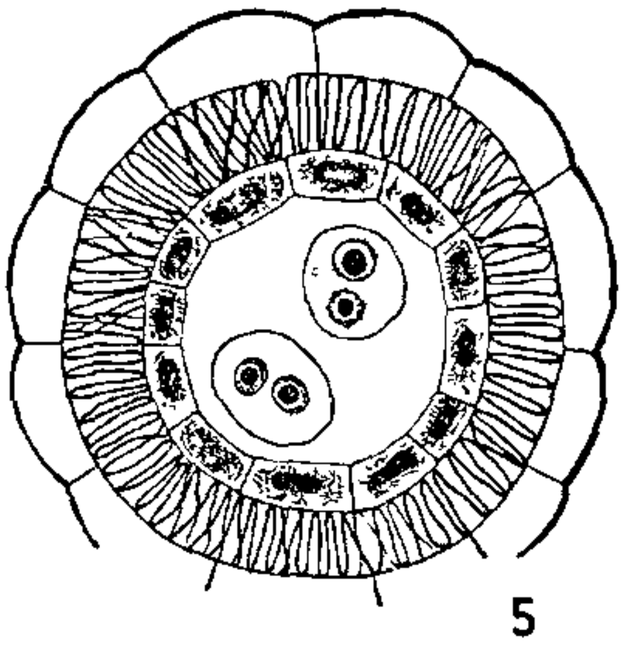

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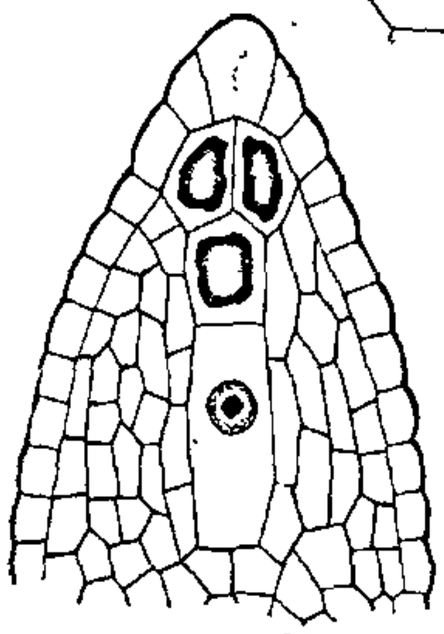

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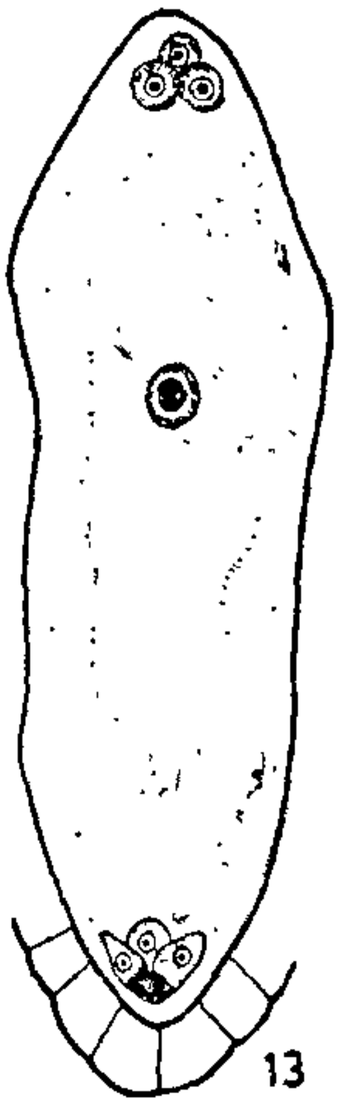

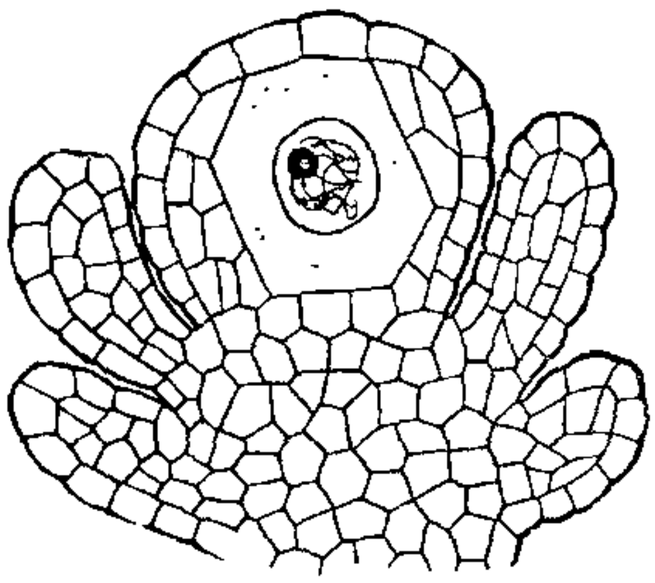

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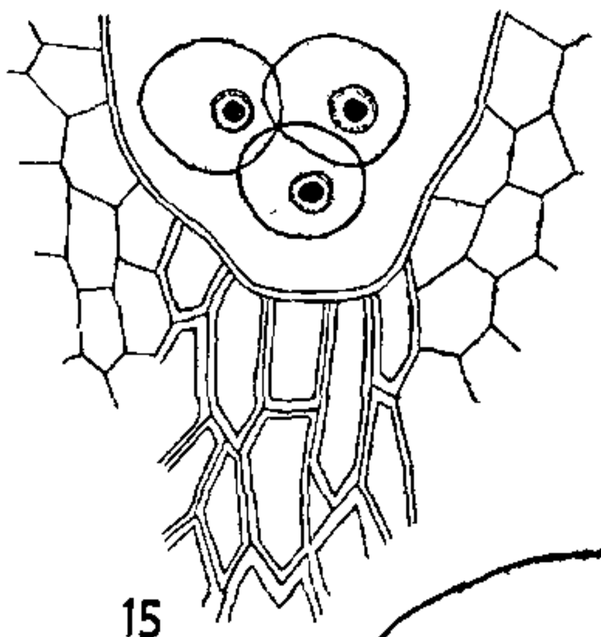

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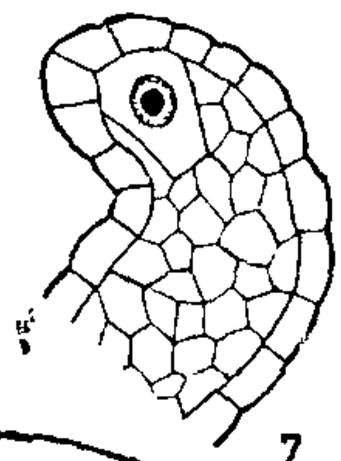

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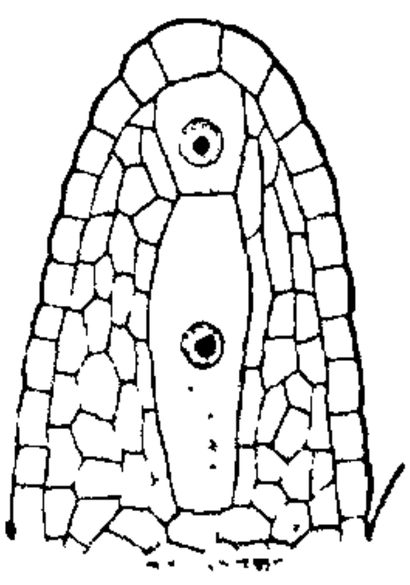

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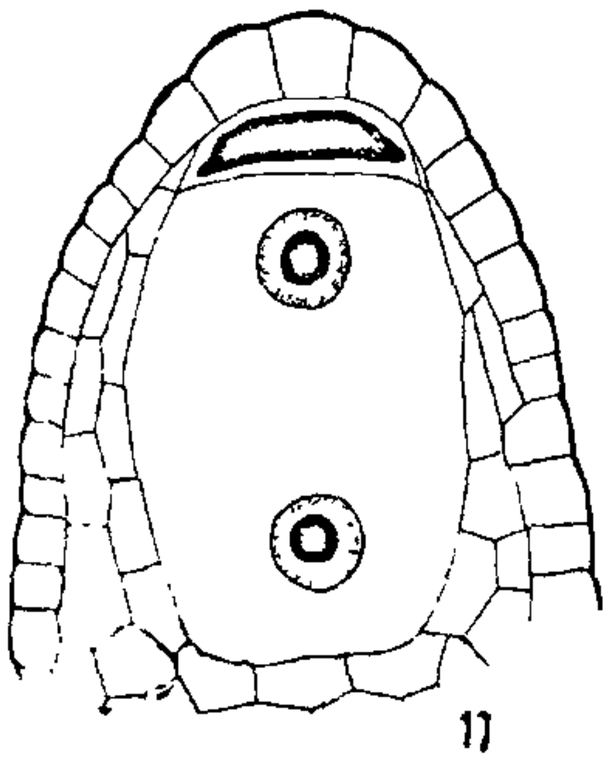

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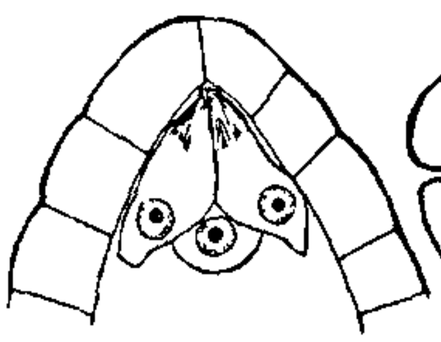

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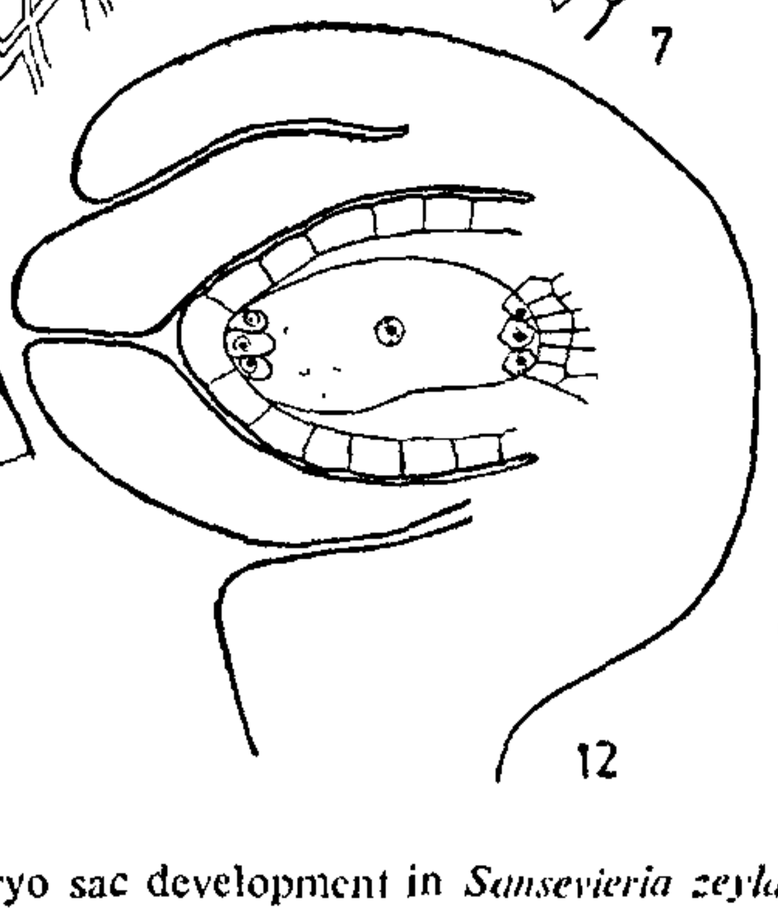

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FIGS. 1–15. Microsporogenesis and embryo sac development in *Sansevieria zeylanica*. Fig. 1. T.s. part of the anther lobe showing the hypodermal archesporial cell, × 150. Fig. 2. Same showing a row of hypodermal archesporial cells, × 90. Fig. 3. Same showing the epidermis, two wall layers, two-nucleate tapetum and sporogenous cell in division, × 120. Fig. 4. Same with two sporogenous cells, × 120. Fig. 5. T.s. mature anther lobe showing the epidermis, fibrous endothecium, glandular tapetum and two-nucleate pollen grains, × 120. Fig. 6. Isobilateral tetrad, × 89. Fig. 7. Ovular primordium with primary archesporial cell, × × 100. Fig. 8. L.s. ovule showing the integument and the archesporial cell, × 120. Fig. 9. L.s. ovule showing the dyad stage, × 120. Fig. 10. Same showing a T-shaped tetrad where the lower megaspore is functional, × 120. Fig. 11. L.s. ovule showing embryo sac at the two-nucleate stage, × 120. Fig. 12. L.s. ovule at the mature embryo sac stage, × 30. Fig. 13. Mature embryo sac, × 120. Fig. 14. Part of the embryo sac showing the egg apparatus, × 120. Fig. 15. Lower part of the embryo sac showing the hypostase, × 150.

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January 1, 1979.

1. Bentham, G. and Hooker, J. D., *Genera Plantarum*, III, 671, London, 1883.
2. Hutchinson, J., *The Families of Flowering Plants. II. Monocotyledons*, Clarendon Press, Oxford, 1957.
3. Lakshmi, N., "Cytotaxonomical and Embryological Studies in Amaryllidaceae and Liliaceae," *Ph.D. Thesis* submitted to Andhra University, 1973.
4. Sharma, A. K., and Chaudhuri, M., *The Nucleus*, 1964, 7 (1), 43.

SURVIVAL OF *AZOSPIRILLUM BRASILENSE* IN DIFFERENT CARRIERS

NITROGEN fixation by *Azospirillum brasilense*[4] is maximum at 25°–35° C[1] and hence it is important to test the efficacy of this organism on various crops under tropical field conditions. One of the prerequisites for large scale field studies is the selection of a suitable carrier material for this organism. It has been reported[2] that soil and farm yard manure (FYM) in the ratio of 1 : 1 is a good carrier and at room temperature (upto a maximum of 35° C), the organism survived upto seven months in this carrier. No quantitative information is available on the proliferation and survival of *A. brasilense* in different carriers at different periods of storage. An attempt has been made to assess the survival of the organism in different carriers quantitatively and the results are reported here.

Six carrier materials, soil, FYM, [soil + FYM (1 : 1)], [soil + FYM + clay (vermiculite) (5 : 3 : 2)], [FYM + clay + charcoal (5 : 2 : 3)] and [soil + FYM + clay + charcoal (1 : 5 : 2 : 2)] were dried to 3% moisture at 80° C and ground to pass through 200 mesh sieve, and the pH of the carriers adjusted to 7·0 with calcium carbonate or with 1 N sulphuric acid. They were sterilized at 15 lb pressure for 4 h in an autoclave for three consecutive days.

A mixture of three-day-old broth cultures of *A. brasilense* (one isolated from the roots of rice var. 'Madhu' and another from *Cynodon dactylon*, a weed grass, grown individually in Okon's medium) was used for inoculation, adding just enough broth to adjust the moisture level to 50% of their water holding capacity. The carriers after mixing with the culture of *A. brasilense* were packed in polyethylene bags and incubated at room temperature (30°–35° C).

TABLE I

Survival of Azospirillum brasilense *in different carriers at room temperature* (30°—35° C)

Treatments	Days of sampling (mean of four replications)							
	Initial	15	30	60	90	120	150	180
	(× 10^8)	(× 10^{10})	(× 10^{10})	(× 10^{10})	(× 10^{10})	(× 10^{10})	(× 10^8)	(× 10^8)
Soil	57–7	1·2	0·001	—	—	—	—	—
Farm yard manure (FYM)	66·0	18·8	31·8	3·5	—	—	—	—
Soil + FYM (1 : 1)	44·3	217·0	700·0	120·0	60·8	10·5	32·0	4·0
Soil + FYM + clay (vermiculite) (5 : 3 : 2)	46·0	351·3	50·8	8·2	—	—	—	—
FYM + clay + charcoal (5 : 2 : 3)	5·3	83·8	29·8	0·7	—	—	—	—
Soil + FYM + clay + charcoal (1 : 5 : 2 : 2)	33·3	28·0	18·8	0·6	—	—	—	—

— : no count at this dilution.