STUDIES IN SEED MORPHOLOGY AND GERMINATION IN JOJOBA (*SIMMONDSIA CHINENSIS* LINK)

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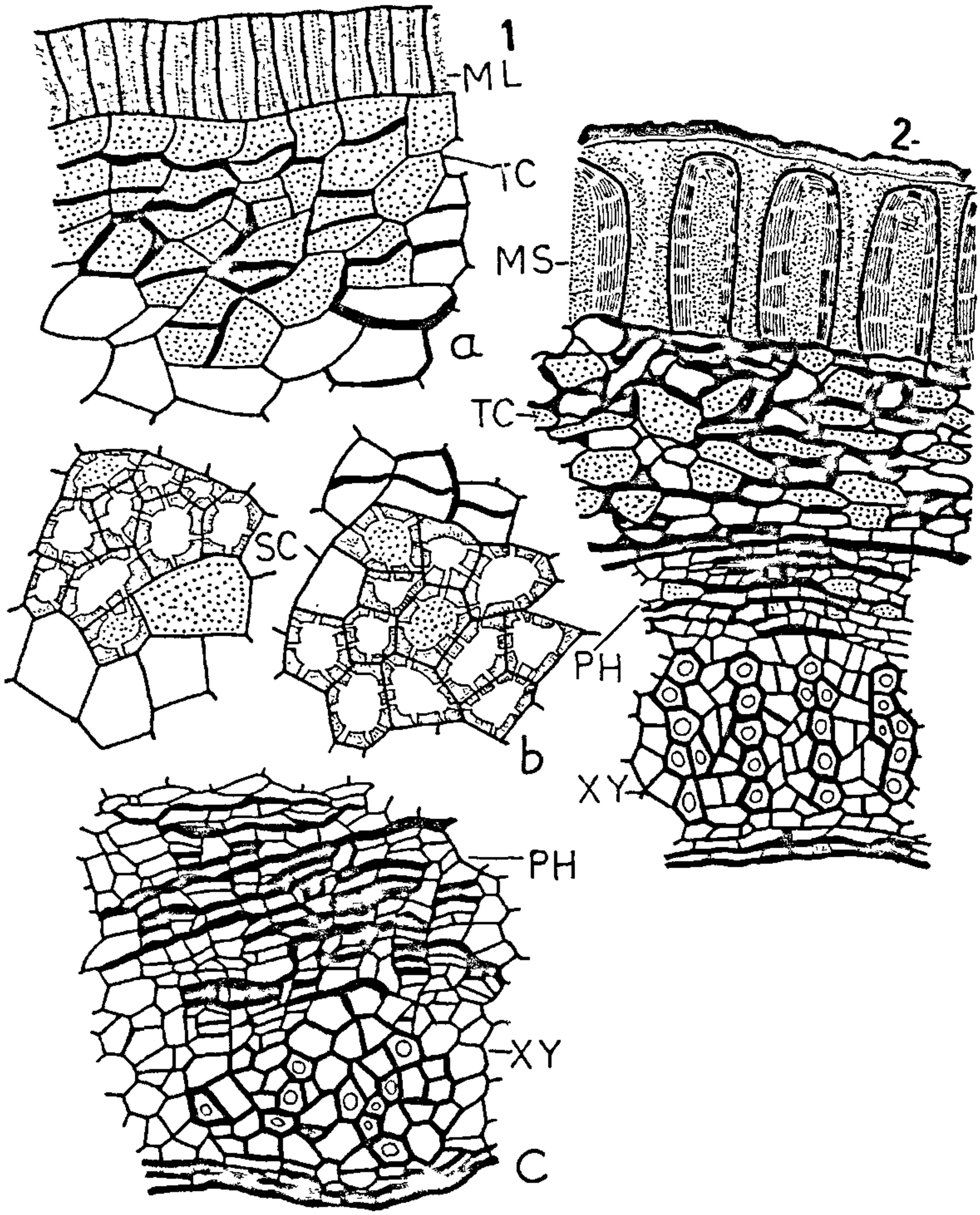
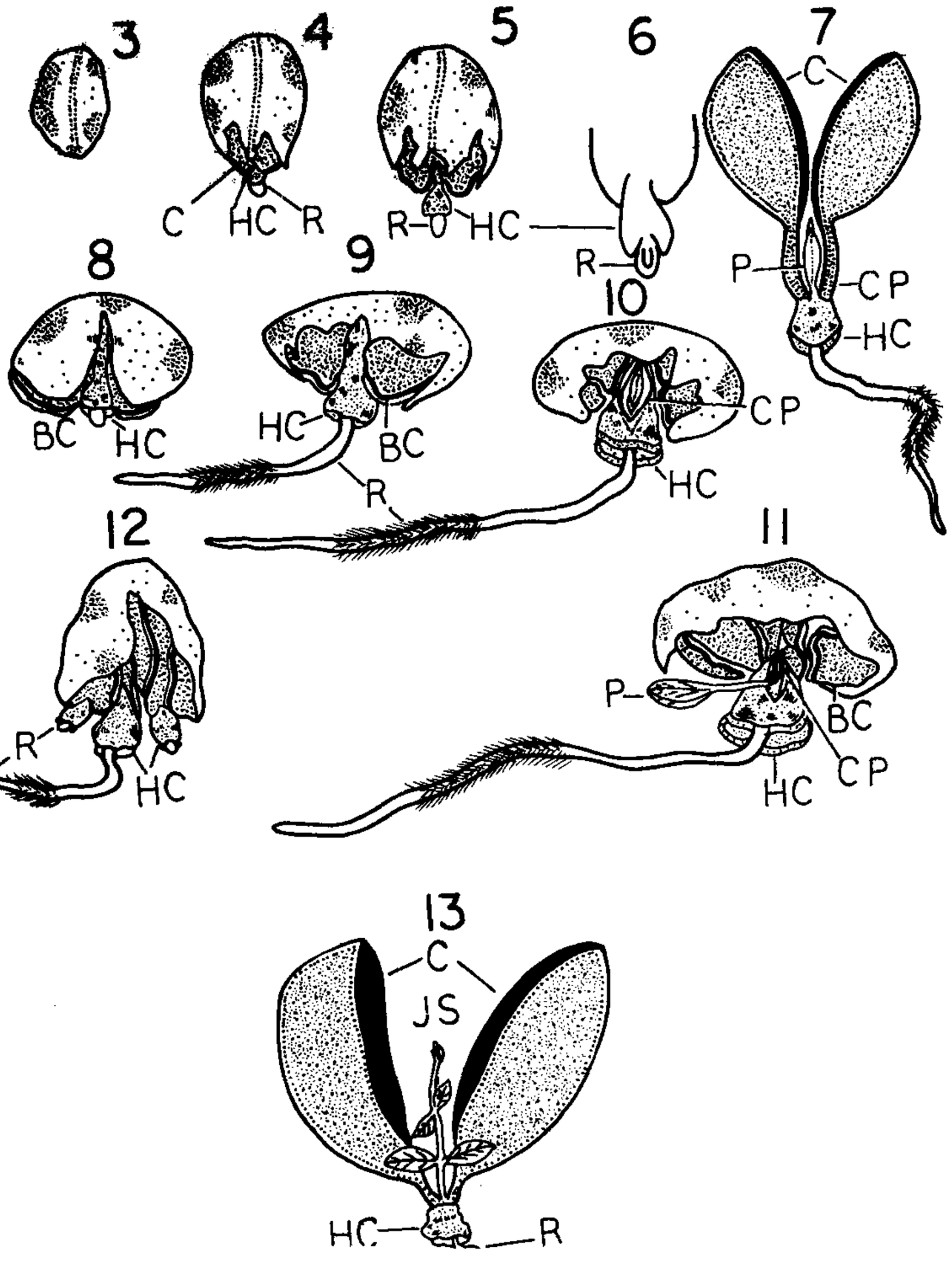
THE dioecious desert shrub Jojoba has commonly the single seeded loculicidal capsules developing from trilocular ovary. The fruit is covered by five perianth lobes and crowned by three styles. The pericarp has a malpighian layer and a mass of parenchymatous tissue with isolated patches of brachysclereids and vascular bundles in the inner extremity (figures 1a, b, c).



Figures 1, 2. 1. Cross section of fruit wall; **a, b, c,** three successive regions in cross section of fruit wall. **a,** malpighian layer and a part of ground tissue; **b,** ground tissue; **c,** vascular tissue × 1200. ML, malpighian layer; PH, phloem; SC, sclereids; TC, tanniferous cells; XY, xylem. **2.** Cross section of testa × 1200. MS, macrosclereids; TC, tanniferous cells; SC, sclereids; PH, phloem; XY, xylem.



Figures 3–13. Seed germination × 6. **3–7,** normal germination. **8–11,** abnormal germination by breaking cotyledons; **12,** three radicles emerging from single seed; **13,** abnormal germination, plumule growing faster than radicle. BC, broken cotyledons; C, cotyledons; CP, cotyledonary petiole; HC, hypocotyledonary cupule; JS, juvenile shoot; P, plumule; R, radicle.

The seeds are nonendospermic and unitegmic. Testa has an epidermis of macrosclereids with unevenly thickened walls followed by parenchymatous ground tissue with vascular bundles towards inner extremity (figure 2).

Germination is hypogeal. Just subjacent to the emerging radicle and partly enclosing it, a hypocotyledonary cupule is found. Plumule emerges when radicle is 10–12 days old and 7–8 cm long. The narrow region of the cupule is considered as hypocotyledonary axis as it is continuous with cotyledonary petioles emerging through micropyle (figures 3–7).

Three types of abnormal germination were encountered. In the first type (3.5%) the cupule and the enclosed radicle emerge perpendicular to micropyle-chalaza axis, not through intercotyledonary crevice but breaking the cotyledons irregularly (figures 8–11). Cotyledonary petioles are perpendicular to cotyled-

ons. In the second type (2%) two or three radicles each enclosed by a cupule emerge and grow normally (figure 12). But only the earlier emerged embryo develops into a plant. Very rarely two seedlings emerge and survive. In the third type (1%) plumule emerges when radicle is 1–1.5 cm long. It grows faster producing miniature leaves while the radicle remained 3 cm long (figure 13).

Schmidt[1] observed no sclerenchyma in the pericarp except the macrosclereides of epidermis. But isolated patches of fibres and brachysclereids have been observed in the ground tissue of the pericarp in the current investigation. Also, protoxylem lacunae observed by Rost and Simper[2] could not be found in the present material. It is probable that they might have mistaken enlarged protoxylem vessel elements for protoxylem lacunae. A significant observation of the present investigation is the presence of vasculature in seed coat, which is a primitive feature found in Gymnosperms and rarely in Angiosperms. Roth[3] recognised coleorhiza as a part of suspensor or hypocotyle. The hypocotyledonary cupule partially enclosing the radicle is hence comparable to coleorhiza. The cupule is absent elsewhere in Dicotyledons. The abnormal germination of the embryo after breaking the cotyledons is probably due to the elongation of suspensor pushing embryo deep into the seed. In this process the orientation of embryo in relation to the polarity of the seed is disturbed resulting in abnormal placement and hence germination.

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1. Schmidt, R., In *La Jojoba, Memorias de la II Conferencia Internacional Sobre*, Baja California, Mexico, 1976, p. 143.
2. Rost, T. L. and Simper, A. D., In *La Jojoba, Memorias de la II Conferencia Internacional Sobre*, Baja California, Mexico, 1976, p. 135.
3. Roth, J., *Flora*, 1957, **144**, 163.

LYTIC PHAGES FOR *BACILLUS THURINGIENSIS* IN THE LOCALITY AROUND CALCUTTA

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THE use of *Bacillus thuringiensis* as an insect pathogen is widely accepted[1]. There are many reports on the presence of phage of *B. thuringiensis*[2-6]. As phage infection may transform *B. thuringiensis* which is apparently non-pathogenic to mammalian pathogenic variety[2], we tried to survey the locality around Calcutta for the presence of the phage. But due to the presence of some spreading type chloroform resistant sporing bacteria in the locality, we were unable to determine phage titer by conventional method. In the present communication we report the phage population in the locality around Calcutta by using a tetracycline and streptomycin resistant strain (developed in this laboratory) of *B. thuringiensis* ATCC 13366.

A strain *B. thuringiensis* TcSm resistant to 100 μg of streptomycin and 20 μg of tetracycline, and pathogenic to *Bombyx mori* developed in this laboratory from *B. thuringiensis* ATCC 13366 was used in the present work. Samples including soils from garden field, river/canals and municipal dumping ground were collected at random. Besides, water and mud from the river and the canals were also taken as samples. In 50 ml sterile stoppered tube, 20 g of soil/mud were brought to 30 ml level by adding sterile water. The tube was vigorously shaken for 30 min and 15 ml suspension were centrifuged at 2000 r.p.m. for 10 min. From the resulting supernatant, 10 ml were treated with 0.5 ml chloroform, 200 μg tetracycline and 1000 μg of streptomycin. The above preparation in 7.5 ml (such high volume was necessary as the phage count was low) portions were mixed with 0.5 ml of *B. thuringiensis* TcSm spore suspension and 2.0 ml of molten and temperate agar medium-I[7] (4 times concentrated and contained 4% agar). This was distributed as seed layer over agar plates containing 25 ml of medium-I supplemented with tetracycline and streptomycin in the above stated concentrations. Plates were incubated and the plaque count was made after 16 hr.

For the determination of phage titer altogether 108 soil samples colleted from the locality around Calcutta were examined. The result (table 1) shows that the highest titer was found in the river/canal side soil or water or mud and a good number of samples were phage-positive in the above mentioned site. In all samples the plaques were round and clear with sharp margin. But the diameter was variable. By noting the diameter, three typical plaques were purified by the conventional method. They were designated as P-1, P-2 and P-3. Although their plaque sizes were found variable under different cultural conditions, the relative plaque size was constant.

For cross infectivity studies with these three phages, the bacteria used were *Bacillus subtilis* NCTC 8236, *B. subtilis* ATCC 6633, *B. cereus* NCTC 10320, *B. cereus* mycoides sub sp. ATCC 11778, *B. pumilus* NCTC 8241 and 50 isolated sporing soil *Bacillus*. Besides these, *B. thuringiensis* ATCC 13366 and its mutants (developed in this laboratory): NSm (resistant to 3000