N. and Kshirasagar, K. K., *Curr. Sci.*, 1962, **31**, 247.
10. Srivastava, M. D. L. and Gupta, Y., *Naturwissenschaften.*, 1962, **24**, 61.
11. Yung, W., *Acta Biol. Exp. Sin.*, 1962, **7**, 371.
12. Sinha, S. S. and Jolly, M. S., *Curr. Sci.*, 1967, **36**, 359.
13. Jolly, M. S., Sen, S. K., Prasad, G. K. and Sengupta, A. K., *Cytologia*, 1979, **44**, 259.
14. Narang, R. C. and Gupta, M. L., *Curr. Sci.*, 1979a, **48**, 465.
15. Narang, R. C. and Gupta, M. L., *Entomon.*, 1979b, **4**, 217.
16. Herwitt, G. M. and John, B., *The statistics chromosoma*, 1967, **21**, 140.

ARRANGEMENT OF COTYLEDONS IN *CITRUS MEDICA* LINN.

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CITRUS MEDICA Linn. (Rutaceae) produces multiple embryos in seed. Each seed contains one large dicotyledonous embryo and 4–6 adventive embryos of nucellar origin. As the seed germinates a cluster of seedlings (large and small) results from both the zygotic and non-zygotic embryos. The non-zygotic embryos show a high frequency of variations in the number of cotyledons and their arrangement. A laboratory study of the seedlings revealed many interesting variations.

Seeds were obtained from mature fruits of plants growing in the Botanic Garden of Madurai Kamaraj University. Individual seeds were cut open to expose the zygotic and non-zygotic embryos. The isolated embryos of each seed were grown in a separate petri dish on filter paper pads moistened with Hoagland's mineral solution. The petri dish with embryos was exposed to daylight in the laboratory and the growth of the seedlings observed periodically. Several sets of petri dishes were maintained.

The embryos which were pale green in colour initially, turned green in three days. Roots were formed in six days and the epicotyl developed in ten days. After fifteen days the seedlings were transferred to sand cultures in plastic containers and watered regularly. After 40 days the seedlings were fixed in FAA for anatomical studies. The zygotic embryo (largest in the seed) developed two oppositely placed cotyledons. The non-zygotic embryos (small in size) had variable number of cotyledons (see figures 1–4 and table 1). Such seedlings developed 'intercotyledonary internode'. Opposite and subopposite cotyledons were also seen in the population of non-zygotic seedlings. Another variation concerns the arrangement of first foliar leaves (simple seedling or juvenile leaves). These were located at one node (opposite phyllotaxy) in the zygotic seedlings, and alternately in a few non-zygotic seedlings (figure 3). The internal structure of the intercotyledonary internode was studied in transverse sections. It was similar to any internode developed subsequently thereby indicating that the alternate condition of the cotyledons is a natural phenomenon.

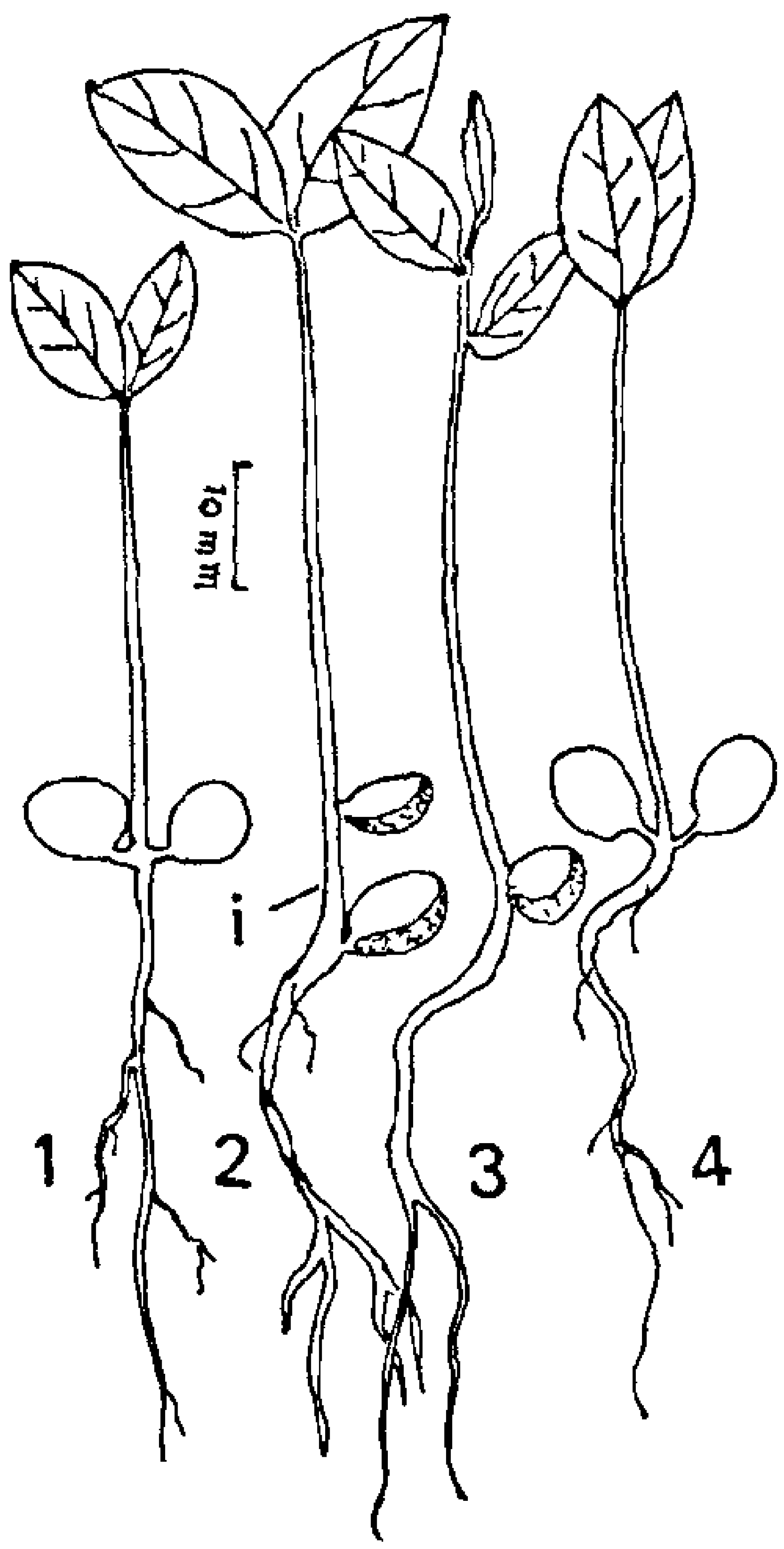
Earlier[1] experiments with the embryos of *Azadirachta* (Meliaceae) recorded the development of intercotyledonary internode as a result of injury. However, a renewed investigation indicates that in *Azadirachta* also non-zygotic embryos are produced and that the seedling populations are heterogeneous. Nair and Kanta[2] reported the occurrence of non-zygotic embryos in *Azadirachta*.

It is possible that the non-zygotic embryos of *Citrus* which resemble embryoids of tissue culture origin

Table 1 *Characters of seedlings of Citrus medica*

Set* Number	Number of Embryos: Zygotic	Non-zygotic	Total	Number of seedlings with: Opposite cotyledons	Alternate cotyledons**	Single cotyledon
1.	3	10	13	5 (38%)	7 (54%)	1 (8%)
2.	3	12	15	4 (27%)	9 (60%)	2 (13%)
3.	3	10	13	6 (46%)	7 (54%)	–
4.	3	8	11	4 (36%)	6 (55%)	1 (9%)
5.	3	11	14	8 (57%)	4 (29%)	2 (14%)

* One set of 3 petri dishes. ** Including sub-opposite.



Figures 1–4. Seedlings of *Citrus medica*. **1.** Seedling of zygotic origin; **2–4.** Seedlings of non-zygotic origin; **3.** Seedling with a single cotyledon; **4.** Seedling with sub-opposite cotyledons. i-intercotyledonary internode.

(both are of vegetative origin) tend to differ from typical seedlings of zygotic origin in morphology. A fresh look at the factors which cause this variation would be rewarding.

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1. Padmanabhan, D. and Muneeswaran, A., *Curr. Sci.*, 1975, **44**, 402.
2. Nair, N. C. and Kanta, K., *J. Indian Bot. Soc.*, 1961, **40**, 382.

EVOLUTION OF CO_2 IN SOIL INFESTED WITH FOUR SOIL-BORNE PATHOGENS OF SUGARBEET SEEDLINGS

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FACULTATIVE parasites often lead a saprophytic life in soil[1-3]. Although several parameters have been used for recording saprophytic activity of an organism, evolution of CO_2 provides a rapid and reasonably good information[4]. Using this parameter, saprophytic activity of four important soil-borne pathogens of sugarbeet seedlings, (*Sclerotium rolfsii*, *Rhizoctonia bataticola*, *R. solani* and *Pythium ultimum*) was studied under controlled conditions in the laboratory. This information will help in understanding the ecological behaviour of these pathogens in soil.

The apparatus designed by Peterson[5] was used for studying soil respiration. The soil used had the following characteristics: 100 g of soil. inoculum (1, 5 and 10%; grown on sand maize meal) was taken in brass wire basket (10 × 3 cm) and hung in 1 litre conical flask containing 25 ml of 0.1N NaOH. The evolved CO_2 was estimated by the method of Pramer and Schmidt[6]. The data on CO_2 produced were recorded at an interval of 4 days and each treatment was replicated thrice. The results were statistically analysed.

Data in table 1 indicate that the quantum of CO_2 produced by all the four pathogens was related to the level of inoculum applied initially, *i.e.* the CO_2 production increased as the level of inoculum increased and this trend persisted throughout the experimental period. Of the four facultative parasites used, the saprophytic growth/activity of *R. bataticola* and *S. rolfsii* was more than *R. solani* and *P. ultimum*, as judged by the amount of CO_2 produced. In *R. bataticola* and *S. rolfsii* the maximum CO_2 was produced by the 4th day, while *P. ultimum* and *R. solani* did so by the 8th day. This suggests (but does not prove) that the former fungi have higher saprophytic growth/activity than the latter ones. Similar results for *Pythium* species have been earlier reported[7-9].

The decrease in CO_2 production, after attaining the peak, may be correlated with the suppression of fungal growth/activity or may be due to the paucity of food material in the soil, as suggested by Papavizas and Davey[10].

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