even the small increase in yield strength caused by solute locking might be getting offset by the decrease in strength caused by dynamic recovery.

Since stress relaxation in the plastic strain range occurs by a process of thermally activated motion of dislocations across the barriers,[12,13] it is possible to calculate one of the activation parameters, *viz.*, the activation volume from the relaxation curves. Activation volume, the product of the length of the dislocation getting activated, the Burgers vector and the width of the barrier, characterises the obstacle to dislocation motion. From the relation between creep and low temperature relaxation, it has been shown[13,14] that the slope 'S' of the curve $\sigma_0 - \sigma$ *versus* ln t is given by

$$S = kT/v \qquad (2)$$

where 'v' is the activation volume, k the Boltzmann's constant and T the absolute temperature. The slopes of the straight lines corresponding to 3·9 and 4·8 kg./mm.^{2} are utilised to calculate the activation volume from Equation (2). The estimated activation volume ($\simeq 2{\cdot}5 \times 10^{-21}$ cm.^{3}) is in good agreement with that reported earlier from creep experiments.[1] While the estimated activation volume suggests that either intersection of glide and forest dislocations or the non-conservative motion of jogs is the rate-controlling mechanism in Indian commercial aluminum, our earlier results based on the combined data of creep and tensile testing indicated that the non-conservative motion of jogs producing point defects might be the most probable one.

Conclusions

Strain ageing experiments on Indian commercial aluminum showed the occurrence of sharp yield point associated with an yield drop. The increase or decrease in the yield strength after ageing depended on the stress level. The analysis of the relaxation curves yielded a value of $2{\cdot}5 \times 10^{-21}$ cm.^{3} for the activation volume.

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TEST-TUBE FERTILIZATION IN *DICRANOSTIGMA FRANCHETIANUM* (PRAIN) FEDDE

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THE technique of test-tube fertilization devised by Kanta *et al.*[1] helps to eliminate the path of pollen tubes through the stigma and style. It is therefore promising in studies on plant breeding and genetics, and has been thus far applied to a few systems.[2-5] This paper reports our successful application of the technique to *Dicranostigma franchetianum* (Papaveraceæ). Plants of this species were raised from seeds obtained from the Direktor, Institute für Kulturepflanzenforschung, Gatersleben, East Germany.

As a prerequisite to our work, anthesis, dehiscence of anthers, pollination, fertilization, and seed development were studied from fresh material and from material fixed in formalin-acetic-alcohol (40% formaldehyde solution 5 ml + glacial acetic acid 5 ml + 70% ethyl alcohol 90 ml). The fixed material was embedded in paraffin following the customary method and microtomed (10–15 μ). The sections were stained in iron hæmatoxylin and erythrosin, and mounted in Canada balsam. Pollen germination and pollen tube growth

were studied also from whole mounts and free-hand sections prepared in 1% iron acetocarmine.

Under the climate of Delhi *Dicranostigma franchetianum* flowers during February-April. Anthesis occurs between 8 and 9 a.m. Anthers begin to dehisce toward the evening the day before anthesis and continue to shed pollen until two hours after anthesis by which time pollination is also accomplished. Pollen germination occurs nearly 30 minutes after pollination and fertilization 24–36 hours thereafter. Six days after pollination a 2- to 4-celled

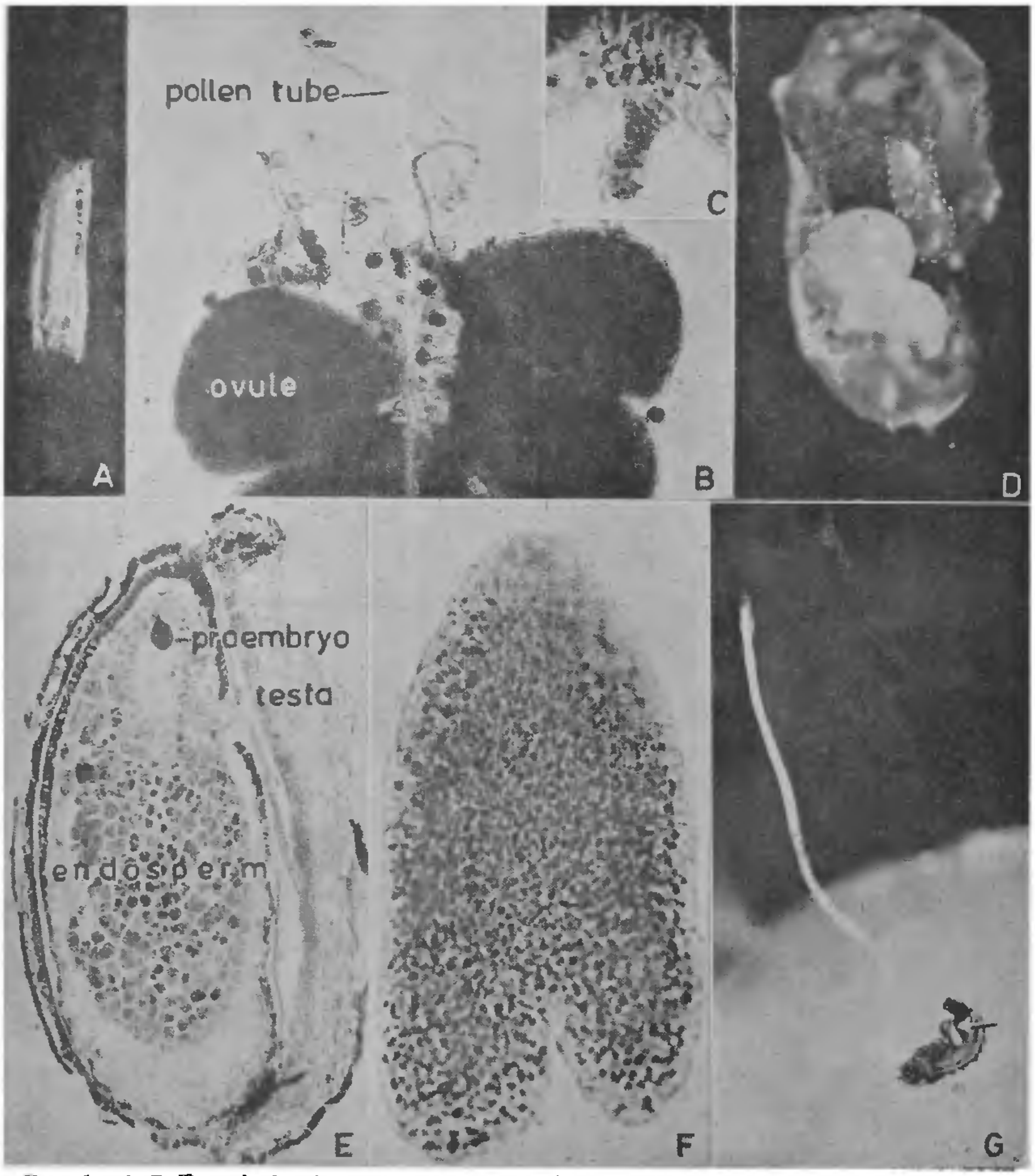

FIG. 1, A–G. Test tube fertilization in *Dicranostigma franchetianum*. A. An explant showing ovary wall, placenta, and ovules, × 6. B. Whole mount of a few ovules removed from a culture 24 hours after pollination; note pollen germination, × 121. C. Longisection of micropylar part of a fertilized ovule from a culture 4 days after pollination. The filamentous proembryo is obvious, × 102. D. 7-day-old pollinated culture showing 4 developing seeds; the 2 that are in profile are highlighted by broken lines; unfertilized ovules are not in focus. × 22. E. Longisection of a young seed collected from a culture 7 days after pollination. Globular embryo and massive endosperm are evident, × 110. F. Whole mount of embryo dissected from seed obtained from 18-day-old pollinated culture, × 345. G. 21-day-old pollinated culture showing seed germination *in situ*. In this view, the seedling does not show the root; the arrow-marked is a recently germinated seed which shows only the emergence of the radicle, × 4.

proembryo is formed in the developing seed. The embryo attains the early heart-shaped stage nearly 10 days after pollination. Mature seeds are formed 15 days after pollination. The mature seed contains a dicotyledonous embryo and a massive endosperm.

To apply the technique of test-tube fertilization, flower-buds were emasculated and bagged one day before anthesis. On the day of anthesis the emasculated buds were excised, their calyx and corolla removed, and their pistils surface-sterilized in fresh chlorine water for about ten minutes and washed twice in sterile distilled water. The ovary was vertically cut such that each half contained one placenta. From each half the tips were discarded, and the remaining portion bearing the ovules, placenta, and ovary wall (Fig. 1, A) was cultured on an agar nutrient medium containing Knop's mineral elements, four B-vitamins, glycine, and sucrose.[6] Thus two cultures were raised from each ovary; one of them was maintained as unpollinated control, and the other was sprinkled with pollen collected at random from about-to-dehisce anthers. In all, 96 cultures were prepared and maintained under 200 Lux diffuse daylight and 22 ± 2° C.

All 48 control cultures shrivelled in 5–8 days. Of the 48 pollinated cultures, 12 shrivelled, 3 became infected, 10 were used for embryologic studies, and the remaining 23 were grown until 21 days. In the pollinated cultures the pollen readily germinated, and the pollen tubes grew amidst the ovules (Fig. 1, B). Three days after pollination 2–5 ovules began enlarging as though they had been fertilized. Embryologic preparations of such enlarging ovules four days after pollination did show 4–8 endosperm nuclei and a zygote or occasionally a filamentous proembryo (Fig. 1, C). This confirmed double fertilization *in vitro*. During six days after pollination the fertilized ovules enlarged considerably (Fig. 1, D) and the unfertilized ovules shrivelled; the young seeds contained cellular endosperm and globular embryo (Fig. 1, E). In 15 days after pollination, mature seeds containing dicotyledonous embryo (Fig. 1, F) and endosperm were formed. Thus, from 23 cultures harvested 18–21 days after pollination, 88 seeds were obtained. Of these 16 seeds germinated *in situ* (Fig. 1, G). Upon harvest, 10 of the remaining 72 seeds were cultured on fresh nutrient medium; 7 of these produced normal seedlings. Studies on root tips of two seedlings showed that both seedlings contained the diploid number of 12 chromosomes.

Thus our investigations have demonstrated that the technique of test-tube fertilization is effective with *Dicranostigma franchetianum* also.

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RADIOCARBON DATES FROM TER AND SOME OTHER HISTORICAL SITES

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ABSTRACT

The C^{14} dates presented are from historical sites. Of special interest are the dates from an Asura site, as also from the late phase of the N.B.P. ware. The samples were counted in the form of methane in gas-proportional counters.

IN the present report are included the C^{14} dates from the sites* of Chandraketugarh, Chirand, Mailaram, Rajbadidanga, Saradkel, Ter, Tripuri and Ujjain.

Each sample has been given two dates in years B.P.; the first one is based on the half-life value of 5568 ± 30 yrs; within the parenthesis is given the second date, based on the half-life value of 5730 ± 40 yrs. To convert the dates to A.D./B.C. scale, 1950 should be used as the reference year (Godwin, 1962).

Before converting the samples into methane, they were pretreated for the removal of extraneous humic acid and carbonates. Rootlets were hand-picked, wherever visible. The samples, in the form of methane, were counted in gas-proportional counters. For modern reference standard 95% activity of the N.B.S. oxalic acid was used. Detailed procedures

* Short summaries of these excavations are published regularly in the *Indian Archaeology—a Review*.