meiotic association and synapsis are two distinct phenomena.

Colchicine is unable to disrupt chromosome association, and so the absence of such association in the hexaploid cells in this study indicates that the chromosomes of these cells were not premeiotically associated when colchicine was applied. This, however, does not necessarily mean that chromosomes are only associated immediately before meiosis, for there may be an association–dissociation cycle operating. This would involve normal association of homologues with disruption to some degree when the chromosomes go through the processes of successive mitoses. Such behaviour has been suggested by Feldman, Mello-Sampayo and Sears[10] following their detection of a vestige of chromosome association in mitotic cells of hexaploid wheat.

C. J. Driscoll
N. L. Darvey
H. N. Barber

Department of Botany,
University of New South Wales,
Kensington.

Received September 11, 1967.

[1] Sears, E. R., and Okamoto, M., *Proc. Tenth Intern. Cong. Genet.*, **2**, 258 (1958).
[2] Riley, R., and Chapman, V., *Nature*, **182**, 713 (1958).
[3] Riley, R., *Heredity*, **15**, 407 (1960).
[4] Riley, R., Chapman, V., and Kimber, G., *Nature*, **186**, 259 (1960).
[5] Riley, R., and Kempanna, C., *Heredity*, **18**, 287 (1963).
[6] Feldman, M., *Proc. US Nat. Acad. Sci.*, **55**, 1447 (1966).
[7] Barber, H. N., *J. Genet.*, **43**, 359 (1942).
[8] Levan, A., *Hereditas*, **24**, 471 (1938).
[9] Nebel, B. R., and Ruttle, M. L., *J. Heredity*, **29**, 3 (1938).
[10] Feldman, M., Mello-Sampayo, T., and Sears, E. R., *Proc. US Nat. Acad. Sci.*, **56**, 1192 (1966).

Effect of "Hardening" Radish Seeds

Subjecting seeds to one or more cycles of wetting and drying before sowing, in the process called "hardening", is said to affect the subsequent growth of plants in adverse environmental conditions. Various Russian workers, cited by May *et al.*[1], have found that such treatment increases the resistance of plants to drought, heat and frost, but others[2] have failed to confirm this. We have therefore grown radish plants from hardened and unhardened seeds, in wet and dry soil conditions at three levels of soil fertility, to find out whether hardening alters yields in different circumstances.

Radish seeds (*Raphanus sativus* L., variety 'Cherry Belle') were subjected to two cycles of wetting and drying, in which they were allowed to absorb water equivalent to about 25 per cent of their dry weight and then air-dried at about 72° F. A range of media, with increasing fertility and water-holding capacity, was compounded by mixing 1 : 2, 2 : 1 and 3 : 0 parts by weight of fertile clay loam and infertile grit, respectively. No fertilizer was added.

Twelve 5 in. plastic pots were filled with each mixture and sown with either treated or untreated seeds a week after the second hardening cycle. The emergent seedlings were thinned to one plant per pot. Within each group of six pots, three were kept moist by rewetting the soil to field capacity whenever 15 per cent of the available water had been lost, as shown by daily weighing, and three were not watered at all after an initial wetting to field capacity at the beginning of the experiment. The pots were housed in a growth room at about 68° ± 1° F and a fluorescent light intensity of about 470 ft.-candles for 12 h daily.

In the moist soil, plants from hardened seeds grew better (Fig. 1) and produced significantly more dry weight than unhardened plants, irrespective of soil fertility, whereas there was no significant difference between hardened and unhardened plants in the dry regime except in the soil with the highest fertility and water-holding capacity.

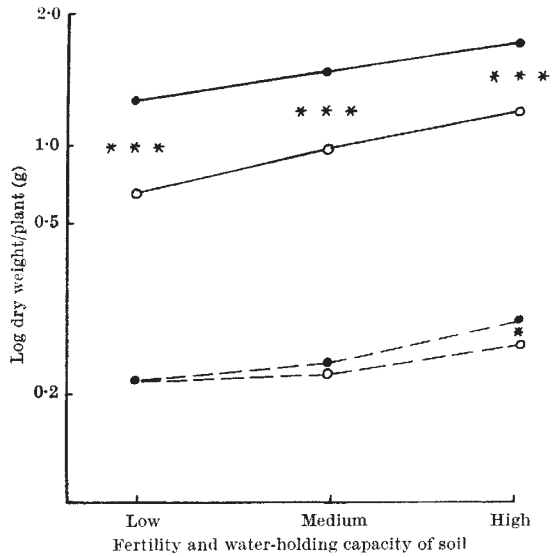

Fig. 1. Effects of seed treatments and soil moisture on growth of radish in three soil mixtures. ●——●, Seeds hardened, moist soil–water regime; ○——○, unhardened, moist; ●- - -●, hardened, dry; ○- - -○, unhardened, dry. *, $P = 0{\cdot}05$; * * *, $P = 0{\cdot}001$.

There was an increase in dry weight with increasing fertility of the mixture, irrespective of other treatments, but there were no striking interactions between any of the treatments. Similar trends were also shown for leaf areas, except that hardened plants in the least fertile mixture had significantly smaller leaf areas than unhardened plants in the more fertile soils.

These results suggest that, at least in some circumstances, "hardening" seeds may confer a greater advantage in favourable than in adverse growing conditions.

A. T. Abdel Hafeez
J. P. Hudson

Department of Horticulture,
University of Nottingham School of Agriculture,
Sutton Bonington,
Loughborough.

Received June 21; revised October 18, 1967.

[1] May, L. H., Milthorpe, E. J., and Milthorpe, F. L., *Field Crop Abst.*, **15**, 171 (1961).
[2] Evenari, M., *Nature*, **204**, 1010 (1964).

GENETICS

Haemoglobin Variant in a Bushman: Haemoglobin Dβ-Bushman$\alpha\beta_{22}^{16Gly\rightarrow Arg}$

Variants of human haemoglobin A with an electrophoretic mobility identical with Hb-S at *p*H 8·6, but not causing sickling, are designated HbD. This type of haemoglobin has been found in many widely separated geographical localities[1]. In six cases the haemoglobins D were structurally identical with the substitution glutamic acid→glutamine at position 121 of the β-chain[2,3]. These samples were obtained from a Punjabi, a Caucasian from North Carolina, an Italian family living in Chicago, a Portuguese, a Greek Cypriot and a white family living in Los Angeles in whom Hb-S was also present.

Two other samples of HbD had different substitutions. One obtained from a Turkish Cypriot was an α-chain variant, and the other came from a Gujerati and had an amino-acid substitution in the region β 18–30 (ref. 4). In northwest India, HbD has been found in frequencies of up to 2 per cent (ref. 5), while only sporadic cases of HbD have been reported from the African Continent[6,7].