Influence of high magnetic fields on meiosis

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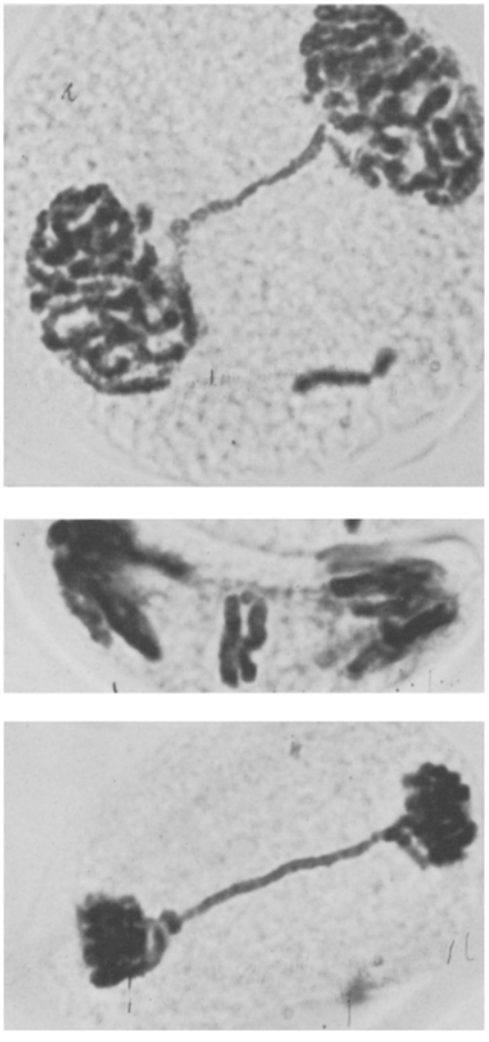
Summary. In a homogenous, high magnetic field, the number of chromosomal aberrations during meiotic division in the sporogenic tissue of lily is increased.

The biological effects of magnetic fields are still controversial[1]. The frequency of mitotic divisions in plant material in magnetic fields seems to be decreased[2], but aberrations are reversible[3]. The biomagnetic effects on plant chromosomes depend on field strength and resistance of the material[4]. Meiotic division has not been exposed to a homogeneous magnetic field until now.

Whereas we observed no significant influence of magnetic field of 10,000 gauss on mitotic frequency in root tips of *Vicia faba*, we found in the sporogenous tissue of anthers that magnetic field increases the number of aberrations.



Typical aberrations of the meiotic division in pollen mother cells of lily. *A* Prophase II with fragment and bridge formation; *B* Anaphase II with 2 chromosomes kept in the equatorial plane; *C* Telophase II with bridge formation.

Anthers of lily (*Lilium henryi* L.), after a treatment of 4 h in a homogeneous magnetic field of 5000 gauss, showed (table) a significant number of disturbed anaphases I and telophases I immediately after the exposition. The deviations are more numerous 18–24 h after the magnetic treatment. The number of disturbed anaphases II and telophases II is significantly higher than the controls. Also the synchronism of the meiotic divisions is reduced, so that various stages are observed at the same time in 1 loculus. But 48–50 h after the magnetic treatment, the number of aberrations is again reduced, so that there is no significant difference compared with the controls. A self restitution can be concluded. The aberrations mostly are bridges, fragmenta- and isolated chromosomes (figure).

Apparently meiosis reacts in the same way on high magnetic fields as mitosis[2–4] does. The explanation of the biomagnetic effects on the meiotic division has to include disorder of the nucleic acid and protein synthesis, since it has been shown that nucleic acids are diamagnetic anisotropic substances[5]. The observed derangement of meiotic division in pollen mother cells may therefore be the result of the DNA and the basic chromosomal proteins forced orientation in the magnetic field.

1 R. L. Liboff, in: Biological effects of magnetic fields, vol. 2, p. 171. Ed. M. F. Barnothy, Plenum Press, New York 1969.
2 S. I. Torodov and N. R. Racheva, Mikrobiol. Fiziol. Biokhim. Rast. *61*, 225 (1966).
3 H. K. Goswani, Nucleus *16*, 24 (1973).
4 E. N. Nemirovich-Dancheno, L. V. Chastokolenko and L. N. Shrager, Biol. Nauk *17*, 65 (1974).
5 G. Maret, M. Schickfus, A. Mayer and K. Dransfeld, Phys. Rev. Lett. *35*, 397 (1975).

Number of chromosomal aberrations in anthers of *Lilium henryi* L. (bud length 18–21 mm) after 4 h exposure between the poles of an electromagnet (AEG ESR spectrometer 20XT) in a homogeneous magnetic field of 5 kg

After treatment	Cytological stage	5000 gauss 4 h Normal	5000 gauss 4 h Disturbed	Control (untreated) Normal	Control (untreated) Disturbed	X^2
0– 2 h	Anaphase I	741	27	491	6	6.38
	Telophase I	520	9	632	3	4.39
18–24 h	Anaphase II	472	12	454	2	12.61
	Telophase II	811	15	546	3	4.12
48–50 h	Telophase II	565	9	600	3	3.71

The temperature between the poles raised during the treatment from 0.2 to 0.5 °C. The treatment was in the dark. Control anthers were placed in the magnet with the magnet switched off. After the treatment the anthers were squashed and stained with 1% orcein in 45% propionic acid. The magnetic field was kindly provided by the Department of Solid State Physics.