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BLANCHI D., L. CEDRINI, F. CERIA, E. MEDA and G. G. RE (Istituto di Fisiologia generale della Università di Torino).

Exposure of mammals to strong 50 Hz electric fields.

1) Effects on the proportion of the different leucocyte types.

male mice exposed to 1 kV/cm field

In the latest years there has been an intensification of the researches concerning the exposure effects of living organisms to strong magnetic, electric and electromagnetic fields, owing to the aerospace enterprises and to the always larger diffusion of e.m. field's sources at both industrial and familiar levels.

Our aim was to investigate the biological effect of the 50 Hz field's electric component, chiefly in regard to the diffusion of the repairs on the high-voltage 'live' lines, with consequent exposure of the workmen to 1-2 kV/cm electric fields [1], which are quite unusual, since the normal electric gradient to which our organism is submitted is about 1 V/cm and reaches exceptionally 10 V/cm during storms.

With the collaboration of the National Electrotechnical Institute Galileo Ferraris of Turin we carried out an experiment of chronic exposure (9 h on, 3 h off, till a total exposure of 1000 h) of small mammals to homogeneous 50 Hz electric field of 1 kV/cm intensity.

Twelve C 57/black mice, all males, were exposed to the field. A parallel group of control animals was placed in the same room and kept in identical conditions of feeding and housing. The animals were kept in perspex boxes between the metallic plates connected to a transformer with voltage regulation on the primary side and delivering up to 50 kV on the secondary one. The lower plate was energized and the upper plate grounded. Care was taken to reduce by suitable devices any corona effect

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and ozone formation, in order to avoid undesirable effects on the animals. The ozone level checked by a Dräger tube was lower than 0.02 ppm, i.e. 0.04 mg/m³.

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The results, summarized in table 1, show at the end of the 1000 h exposure an increase of the neutrophils and of the eosinophils in the exposed mice, in comparison with the control mice, of respectively 98.5% and 44.0%, together with a decrease of 17% in the lymphocytes percentage.

TABLE 1

	1000 h exposure				
	Neutrophils %	Eosinophils %	Basophils %	Lymphocytes %	Monocytes %
	mean ± S.E.				
Exposed	24.90 ± 3.279	4.10 ± 0.310	0.25 ± 0.048	67.50 ± 3.185	3.24 ± 0.163
Controls	12.52 ± 1.193	2.86 ± 0.446	0.19 ± 0.061	81.41 ± 1.614	3.06 ± 0.337
Difference E-C	+ 12.38 P < 0.01	+ 1.24 P < 0.05		- 13.91 P < 0.01	

Analogous results have been observed in rats, which were submitted to an acute exposure of 6 h: neutrophils and eosinophils reached a maximum of respectively 133.5% and 187.6% (percentage variations referred to the values of 24 h before the exposure) 25 h after the removal of the field; at the same time, lymphocytes showed minimum of -25%. Within 9 days the proportion of the white cell types came back to the normal values, with the exception of the eosinophils in some case.

It is noteworthy that these changes in the percentage of the different white cell types agree with those observed by BARNOTHY [2] in mice expos-

ed to a strong (4200 Oe) magnetic field (decrease of the total number of the circulating leucocytes, increase of the ratio $\frac{\text{neutrophils} + \text{eosinophils}}{\text{lymphocytes}}$ and by this Author ascribed to a different inhibition's degree exerted by the field upon lymph nodes and bone marrow.

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Exposure of mammals to strong 50 Hz electric fields.
 2) Effects on heart's and brain's electrical activity.

Electrocardiograms of all the exposed and control mice which were submitted to the experiment described in the previous communication were recorded at 500 and 1000 h from the start of the exposure. The results, summarized in table 1, show that a total exposure of 1000 h to the field leads to a statistically significant lengthening of the PR interval (19.5% in respect of the control animals), of R wave's duration (25%) and of QRS complex duration (19.5%).

In Guinea-pigs submitted to an acute exposure of $\frac{1}{2}$ h to the field, it has been observed the appearance of a marked sinusal arrhythmia, beginning from 10-20 minutes after the removal of the field and lasting about 10 minutes.

It is noteworthy that a lengthening of the QRS complex was found by SACHIKOVA [1] in persons chronically exposed to electromagnetic fields in the UHF and SHF frequency ranges. An increase of the sinusal arrhythmia, owing to the exposure to strong magnetic fields, was observed by BEISCHER [2] in Primates and by YOUNG [3] in the amphibian's vagal heart preparation.

EEG recordings were carried out by means of epidural electrodes in several Guinea-pigs before, during and soon after an exposure of 30 minutes to the 50 Hz field; they have shown that this field leads to transitory changes in the EEG activity, which are quite similar to those observed by many authors [4, 5] in mammalian exposed to magnetic

TABLE 1

	1000 h exposure		
	PR ms	R ms	QRS ms
	mean ± S.E.		
Exposed	45.24 ± 1.402	6.95 ± 0.375	9.17 ± 0.485
Controls	38.02 ± 0.102	5.59 ± 0.242	7.71 ± 0.250
Difference E-C	+ 7.22 P < 0.01	+ 1.36 P < 0.01	+ 1.46 P < 0.05

(Intervals are intended between peak values of the ECG waves)

and HF, UHF, SHF electromagnetic fields. These changes consist in: i) appearance of slow-frequency high-amplitude waves which persist during the whole exposure to the field; ii) increase in the number of spindles during the exposure to the field; iii) short-term desynchronization, which occurs soon after the application of the field. Often it was also observed an off-response, consisting in a short-term desynchronization soon after the removal of the field.

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Pressione arteriosa e frequenza cardiaca nel coniglio in ipnosi animale.

L'ipnosi animale nel coniglio è uno stato di immobilità transitoria, caratterizzato da abolizione dei riflessi di raddrizzamento, ipotonia e depressione dei riflessi spinali mono e polisinpatici. Nelle presenti ricerche, la pressione arteriosa è stata misurata in dieci conigli per mezzo di una cannula di teflon impiantata permanentemente nell'arteria femorale e connessa a un trasduttore. L'ipnosi era indotta mettendo l'animale in posizione dorsale per pochi secondi e abbandonandolo soltanto quando non opponeva più resistenza. Gli episodi erano indotti a intervalli di circa un'ora. Tutte le stimolazioni sensoriali capaci di interrompere l'ipnosi erano accuratamente evitate. La pressione arteriosa era registrata in continuazione per tutta la seduta sperimentale. Come controlli si misuravano quei periodi di veglia, della durata di 45-120 secondi, durante i quali l'animale non si muoveva. Si osservarono grandi differenze individuali: i valori della pressione sistolica media variavano fra 115 e 145 mm Hg, quelli della diastolica tra 55 e 75 e quelli della frequenza cardiaca fra 180 e 320 al minuto. Tuttavia per uno stesso animale le deviazioni *standard* dalla media erano sempre minori del 3% per la pressione sistolica e la frequenza cardiaca, e minori del 5% per la diastolica.

Durante l'induzione dell'ipnosi si osservò un aumento sia della pressione sistolica che della diastolica. Nel momento in cui l'animale veniva