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BIOLOGICAL ALTERATIONS OBSERVED UNDER MICROWAVE IRRADIATION

Recent works performed

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One of our research program was to bring to evidence the microwave biological effects ; actually we are studing :

- the nervous and neuro-muscular conduction.
- the organism granuloplectic activity and immune response after exposure at various frequencies; our goal being to realize a frequency exploration with constant absorbed power.

Our precedent research works allowed us to demonstrate the action of microwaves on the nervous conducting speed of the frog sciatic nerve.

The choice of material, the technology used and results obtained have been the subject of previous papers [(1), (2)] .
However, for memory, we shall recall the conclusions : a systematic study with frequencies from 1 to 11 GHz allowed us to observe a diminution of the conducting speed about 10 % in 5 to 6 GHz range (Fig. 1).

The works for which we shall present the results below have been realized on the SWISS ♂ mouse.

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We adopted the same mounting for all our experiments (Fig. 2). The radiations were made in multimodes cylindrical cavities for groups of 12 animals. The cavities were 600 cm² section and 15 cm height. The power utilized is 300 mW in C.W.. The VSWR is maintained inferior to 1.5 by classical means. The radiations are made during 9 nights with a period of 15 hours per cycle of 24 hours.

We can judge of the effect of this exposition on the tenth day by comparing the results with the control animals put in identical cavities during the same time but without being radiated.

I - SENSIBILITY TO CURAR DRUGS

The first works realized in FRANCE by SERVANTIE [(3)] have shown that rats exposed to 3 GHz pulsed radar waves seem to be less sensitive to curar drugs.

Our experiments were made on 150 mice.

The animal being placed on dorsal decubitus, the breath motions being recorded with a displacement transducer, it is possible to appreciate the activity of the curar drug (gallamine) administered by means of a 500 µg/ml/mn intra-peritonitis perfusion until a definitive breath stop.

The study of the recording shows three successive phases : firstly, normal breath motions which are followed by breath spasms and finally by temporary breath stops and a definitive breath stop.

Our experiment realized at 3 GHz allowed us to observe that the gallamine doses determining the spasms apparition and the definitive breath-stops are higher on radiated animals than on control ones.

Although the difference is small, these results are confirming those of SERVANTIE.

We intend to complete this study by changing some of the physical parameters and by the use of a pulsed field.

II - MODIFICATIONS OF THE IMMUNE RESPONSE

Very few works performed are known in this field. In U.S.S.R., CUKHLOVIN [(4)] has observed an inhibition of the antibody formation during chronic radiations. In FRANCE, PAUTRIZEL [(5)] noted important variations of the animals immune response.

Our study was carried on 380 animals.

We induce on the mouse the formation of some sheep red blood cells antibodies according to PREVOT and RAYNAUD method [(6), (7)]. To that effect, we inject in each animal 250 µg suspended corynebacterium granulosum and 3 days after, 0.2 ml suspended sheep red blood cells (1.10^8 red blood cells). On the tenth day, the animals were killed and the blood collected. After de complementation of the serum, we dose the sheep anti-red blood cells antibodies rate with the hemagglutination blood disc method.

In order to obtain more precise results, dilutions are effected in an arithmetical progression contrary to a geometric progression.

To judge the microwave effect, we calculate H coefficient representing the fraction value usually used to express the antibody rate (ex. if $T = \frac{1}{500}$; $H = 2.10^{-3}$), then ΔH is the difference between radiated and control animals (these values are shown on Fig. 4).

We observe that the microwaves have different effects depending of the radiation frequency. Generally, the antibody rate is not modified ; however, it slightly increases at 2.4 and 3.9 GHz and also quite reduces at 4.9 GHz where the difference between radiated and control animals is significant.

Other tests at this frequency confirmed the results obtained previously.

III - MODIFICATIONS OF THE GRANULOPECTIC ACTIVITY OF THE RETICULO-ENDOTHELIAL SYSTEM (R.E.S.)

The action of electromagnetic waves on the pectic activity of the phagocytes of R.E.S. has not been thoroughly studied. However PLURIEN and Coll. [(8)] have observed two periods in the variations of the R.E.S. during chronic radiations (5 and 15 mW/cm²).

We realized a systematic frequencies exploration studying for each of them the granulopectic activity of the R.E.S. previously stimulated by corynebacterium granulosum. The exploration method of the R.E.S. is that recommended by HALPERN and Coll. [(9)]. The principle of this technique lies on the progressive purification by the R.E.S. of carbon colloidal particles. The carbon blood concentrations are evaluated by spectrophotometry at 650 nm. According to HALPERN, we shall call K the global granulopectic index given by :

$$K = \frac{\text{Log } C_1 - \text{Log } C_2}{t_2 - t_1}$$

We also calculate α which is the corrected granulopectic index :

$$\alpha = \sqrt[3]{K \cdot \frac{P_c}{P_o}}$$

P_c = weight of the animal

P_o = weight of spleen and liver

We also retained K_{up} parameter showing the pectic activity of the phagocytes brought back to the organ weight units (liver and spleen).

Our results were carried out on 520 animals.

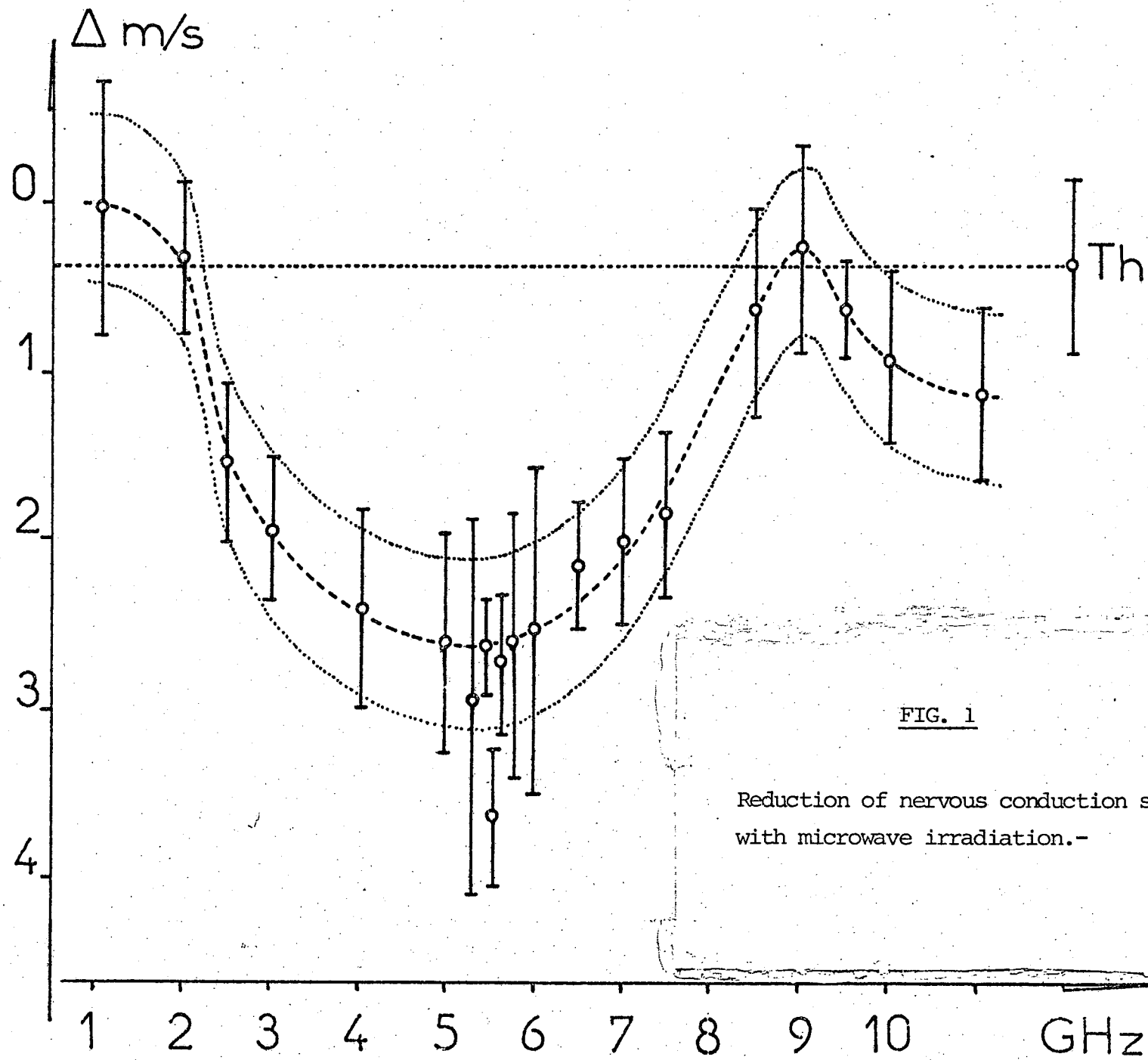
The attached table gives the comparative values of K, α and K_{up} indexes obtained on control and radiated animals (test animals) at different frequencies.

In our experimental works, after exposure to microwaves, the phagocytosis activity of R.E.S. cells decrease usually quite well. In fact, we observe a diminution of K and Kup (except at 1,9 GHz) and the index α shows a decrease quite clear at 2,4 GHz. However, the statistical tests have not shown significant values although we well observed the variations.

IV - CONCLUSION

Our tests were carried on more than 1000 animals and they show a non negligible effect of the electromagnetic waves on the mouse, even the utilized power was weak. A few frequencies seem more active than others on some physiologic phenomenon, the absorbed energy being constant.

Nevertheless, our laboratory will complete their studies with a research of other parameters (power, radiation time, pulsed wave) which will allow on one hand to confirm and improve the actual results and on the other hand to define better the true risks that exposed man encounter every day.



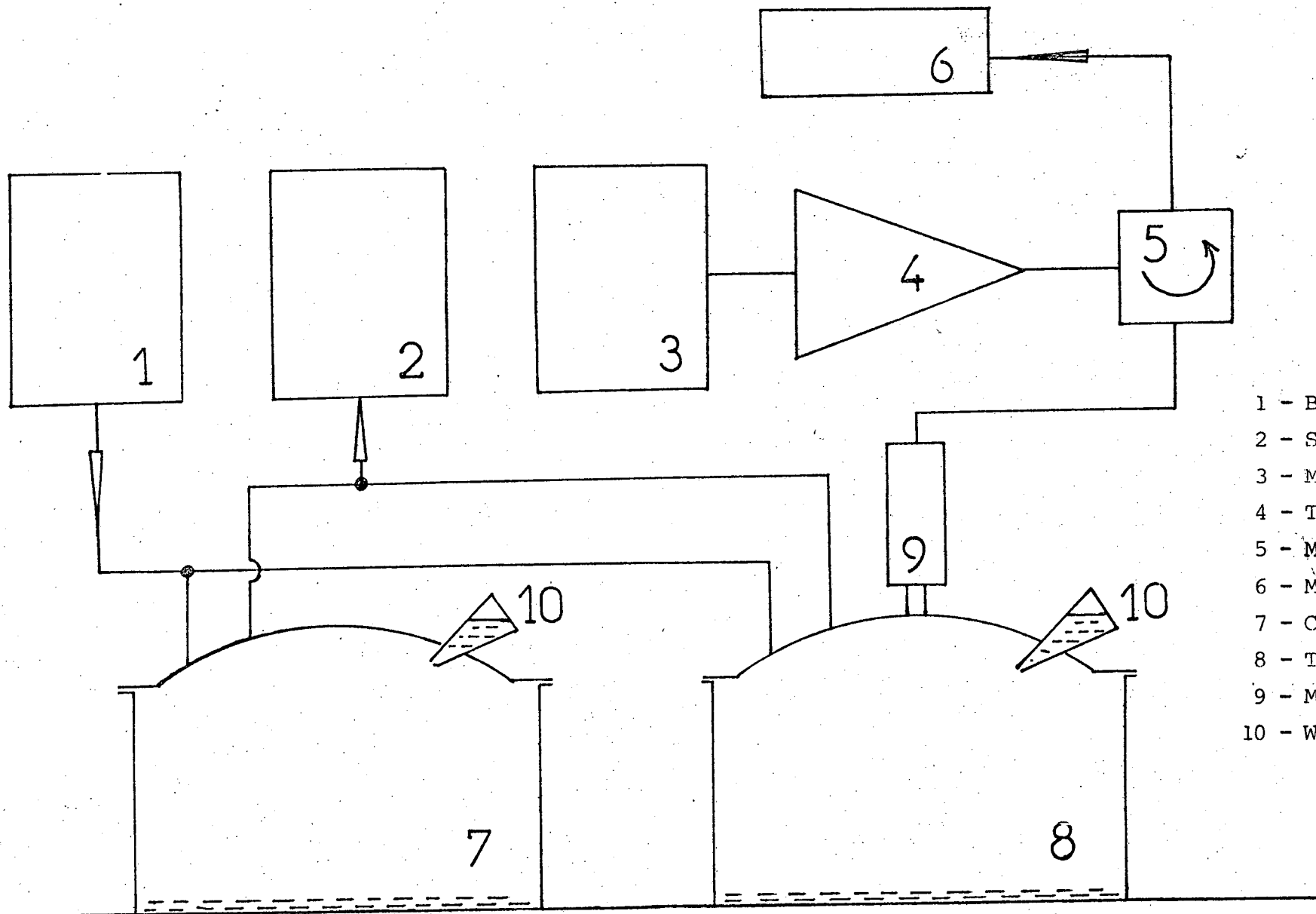


FIG. 2

- 1 - Blowing apparatus
- 2 - Suction pump
- 3 - Microwave oscillator
- 4 - T.W.T. Amplifier
- 5 - Microwave circulator
- 6 - Milliwatt meter
- 7 - Control chamber
- 8 - Test chamber
- 9 - Microwave adaptor
- 10 - Water

Log of doses
in $\mu\text{g}/\text{animals}$

Log of times
in secondes

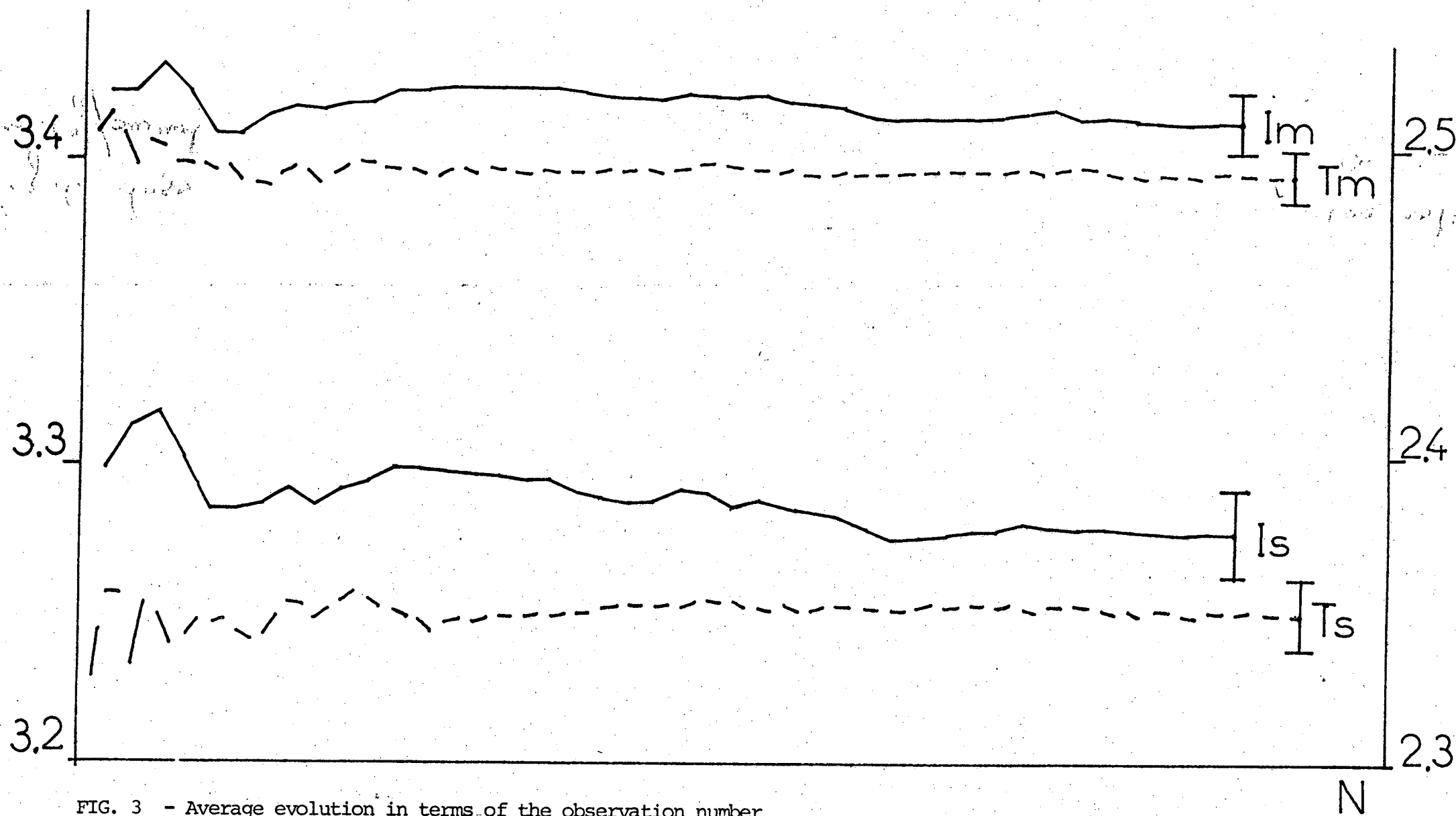


FIG. 3 - Average evolution in terms of the observation number

T_S : Log of appearance time of control spasm

T_M : Log of appearance time of control stop breathing

I_S : Log of appearance time of test spasm

I_M : Log of appearance time of test stop breathing

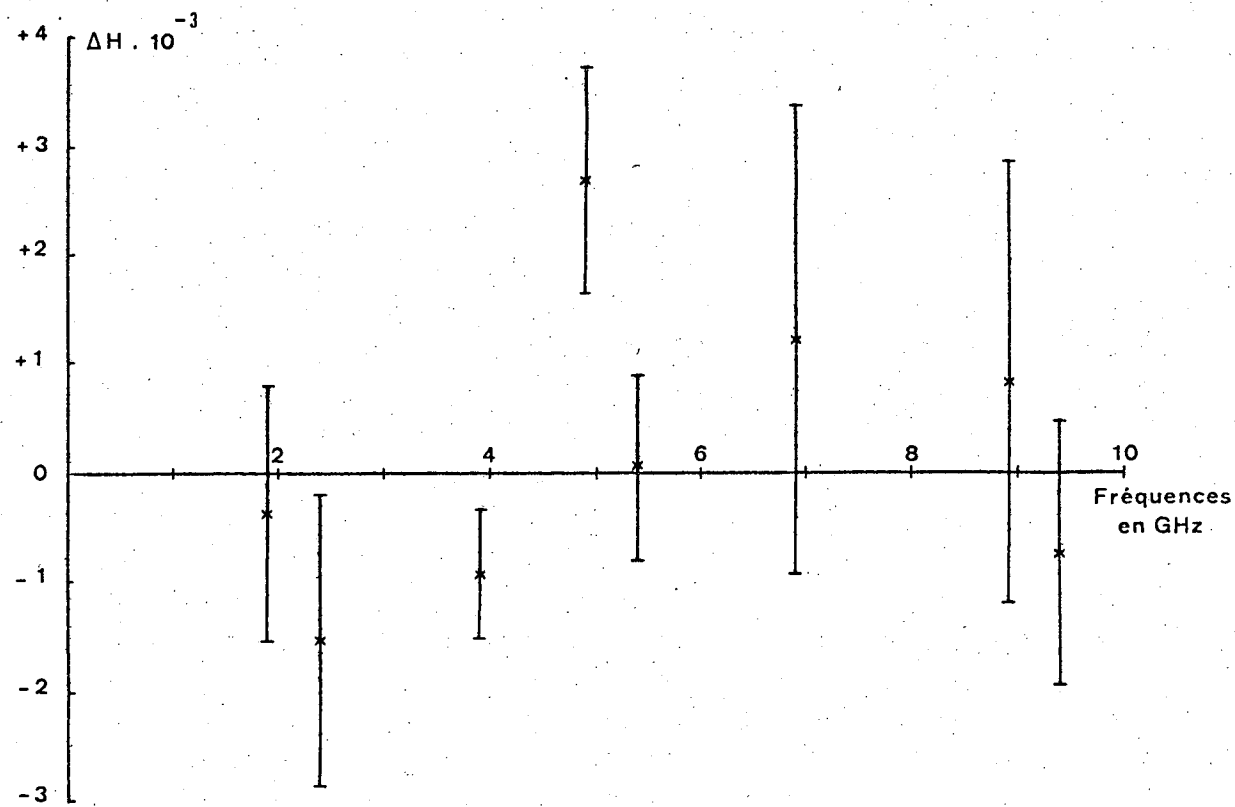


FIG. 4

Variations of antibody rate difference between tests and controls in terms of frequencies.-

Comparative values of granulopexic index in terms of frequencies.-

Number of animals	Frequencies in GHz	Index K	Index α	Index Kup	Groups' nature
24		0,086	6,01	4,01	T
22	1,9	0,089	5,99	4,00	I
24		0,067	5,73	3,32	T
24	2,4	0,058	5,48	2,92	I
21		0,126	6,31	5,30	T
24	2,4	0,111	6,16	4,79	I
22		0,126	6,12	5,72	T
22	2,4	0,128	6,06	5,59	I
24		0,094	6,09	4,05	T
24	3,9	0,086	5,92	3,72	I
22		0,140	6,24	6,19	T
20	4,9	0,127	6,35	5,75	I
22		0,126	6,12	5,72	T
22	4,9	0,125	6,03	5,41	I
24		0,096	6,22	4,66	T
24	5,4	0,086	6,26	4,55	I
24		0,085	5,85	3,87	T
23	6,9	0,076	5,98	3,70	I
22		0,087	5,81	3,87	T
23	8,9	0,073	5,68	3,43	I
31		0,113	5,74	4,84	T
36	9,4	0,110	5,76	4,84	I

T = Control

I = Test