ACTIVATION OF METAL IONS AND BIOLOGICALLY ACTIVE COMPOUNDS IONS ACTION BY COMBINED MAGNETIC FIELD (CMF)

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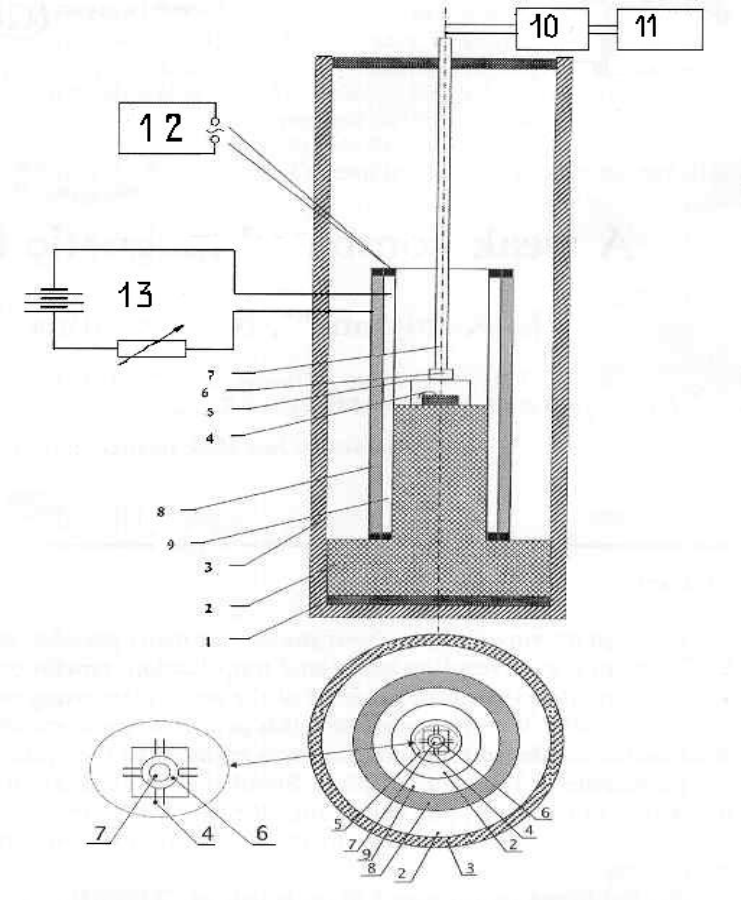
- **The main ideas of the work are:**

1. **To show that Ca^{2+} ions take an immediate part in the processes induced by CMF and in gravitropic reaction, to receive the dependences on concentration of Ca^{2+} ions.**
2. **2. To activate the action of biologically active organic compounds by CMF.**

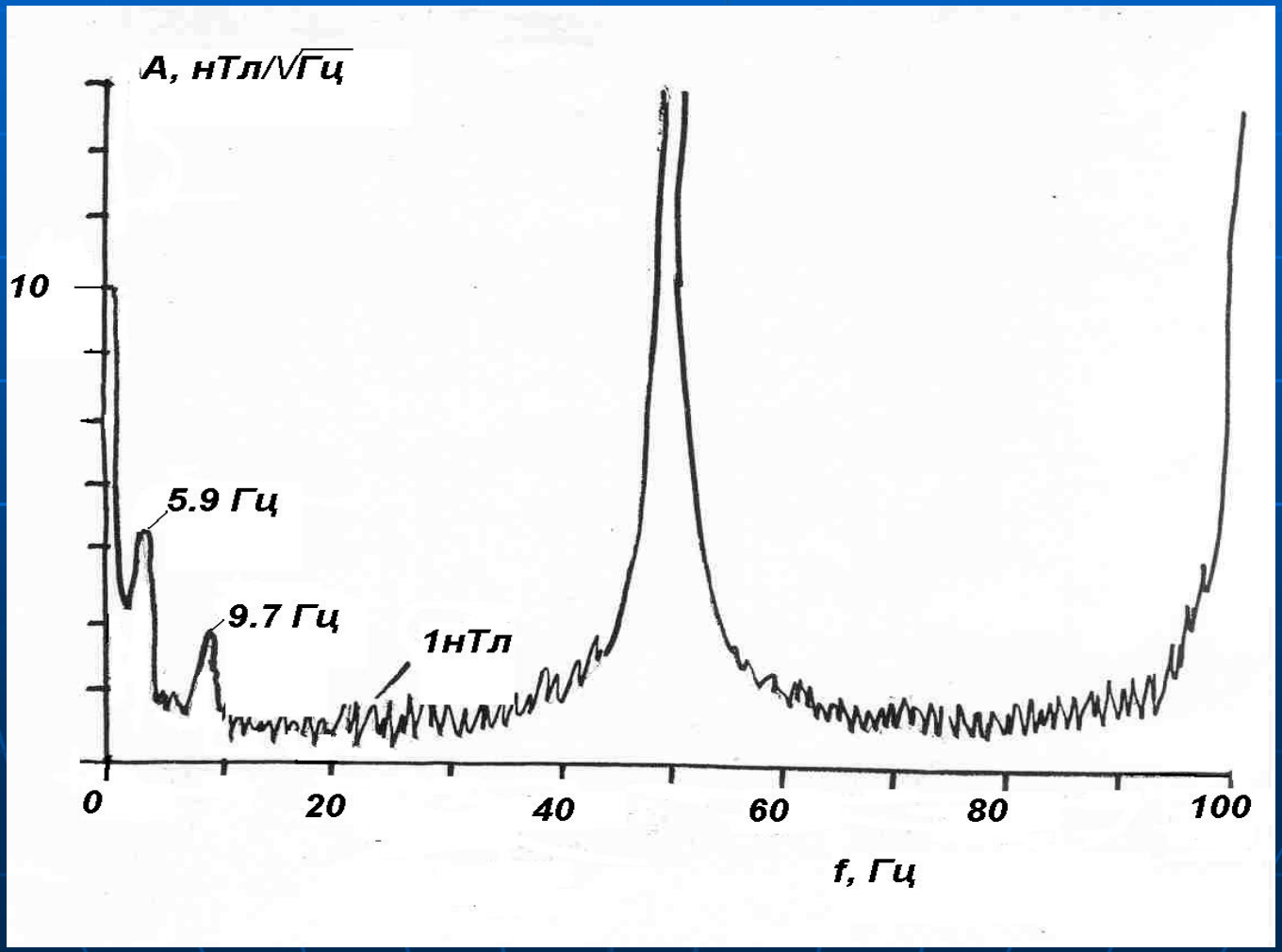
The external sight of set

Scheme of experiment

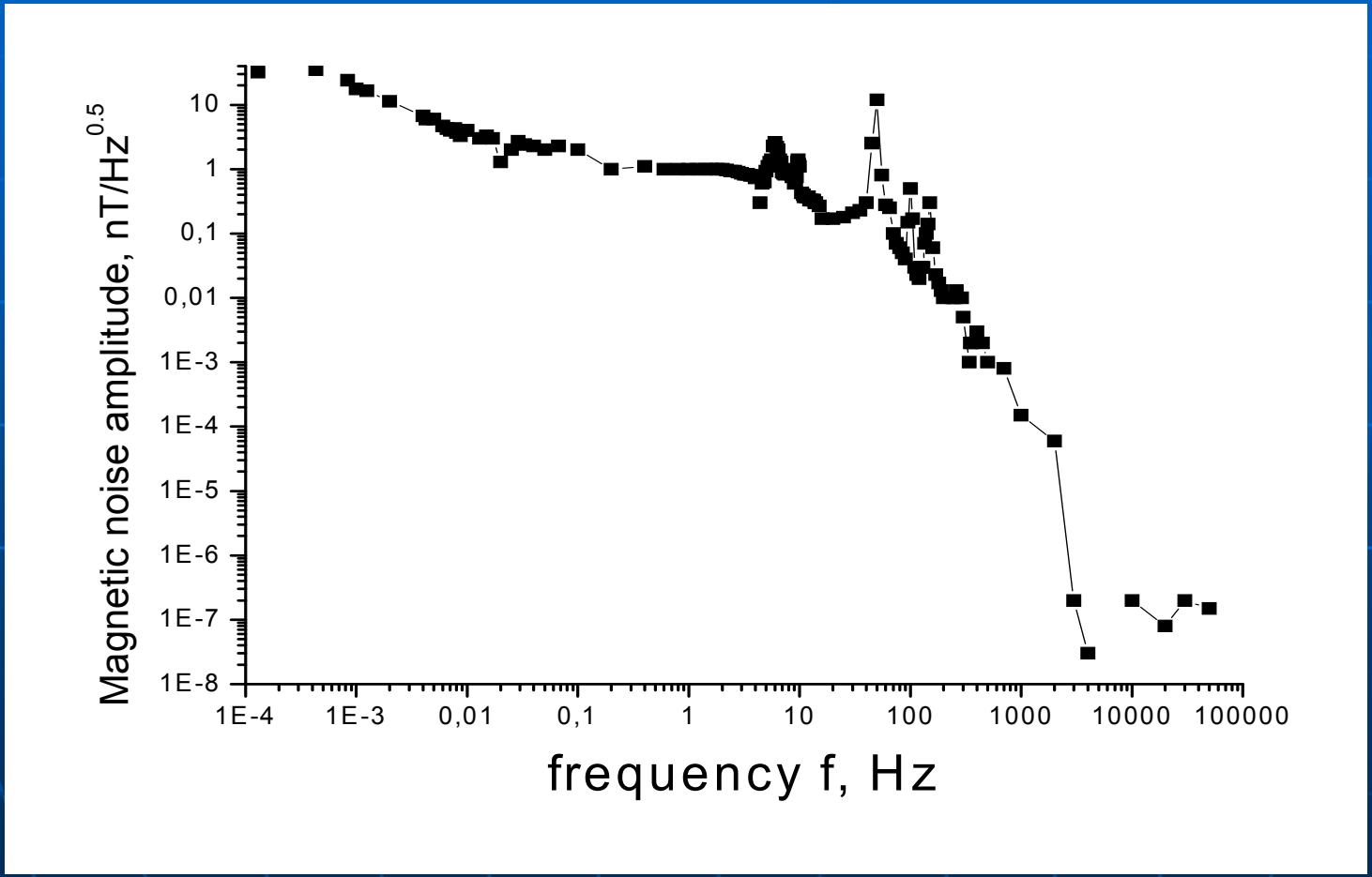


The damping rubber (1) supported the holder of dielectric material (2). The μ-metal shield (3) surrounded the samples (4) that were mounted inside a moist chamber of non-magnetic plastic material (5) and solenoids (8, 9). The magnetic field was measured and controlled by sensor elements (fluxgate magnetometer or SQID), (6) inside a holder (7). The solenoids (8, 9) have a cylindrical shape and comprise the system that generates the static magnetic field (9). Both static and alternating magnetic fields are oriented parallel to the central axis. The enlarged central part of the top view shows the orientation of 4 pairs of roots (4), arranged around the magnetic field sensor (7). The coils of solenoids (8, 9) are the spaces between the circles in the bottom part. The space between the innermost circle is the holder of dielectric material (2).

The dependence of amplitude of spectral density of magnetic noise for the system: superconductive shield + flux gate magnetometer



The dependence of amplitude of spectral density of magnetic noise for the system: μ-metal shield + flux gate magnetometer (10^{-4}-100Hz) or μ-metal shield + induction method (16Hz-100kHz). Results of different measurements in the region 16-100Hz coincides between themselves very well



Comparison of gravitropic reaction (GTR) of experimental samples after the treatment by CMF (B_{DC}=8.6 μT, B_{AC}=15.85 μT, f=6.84 Hz) with GTR of control samples (B_{DC}=8.6 μT, B_{AC}=0 μT, f=0 Hz)



experiment



Control

a b c

The samples were germinated beforehand in Ca solution with concentration-0.044g/l.

a – time of action is 0 minutes, b – time of action is 30 minutes, c – time of action is– 60 minutes. Temperature T=23° C.

Comparison of gravitropic reaction (GTR) of experimental samples after the treatment by CMF (B_{DC}=8.6 μT, B_{AC}=15.85 μT, f=6.84 Hz) with GTR of control samples (B_{DC}=8.6 μT, B_{AC}=0 μT, f=0 Hz)

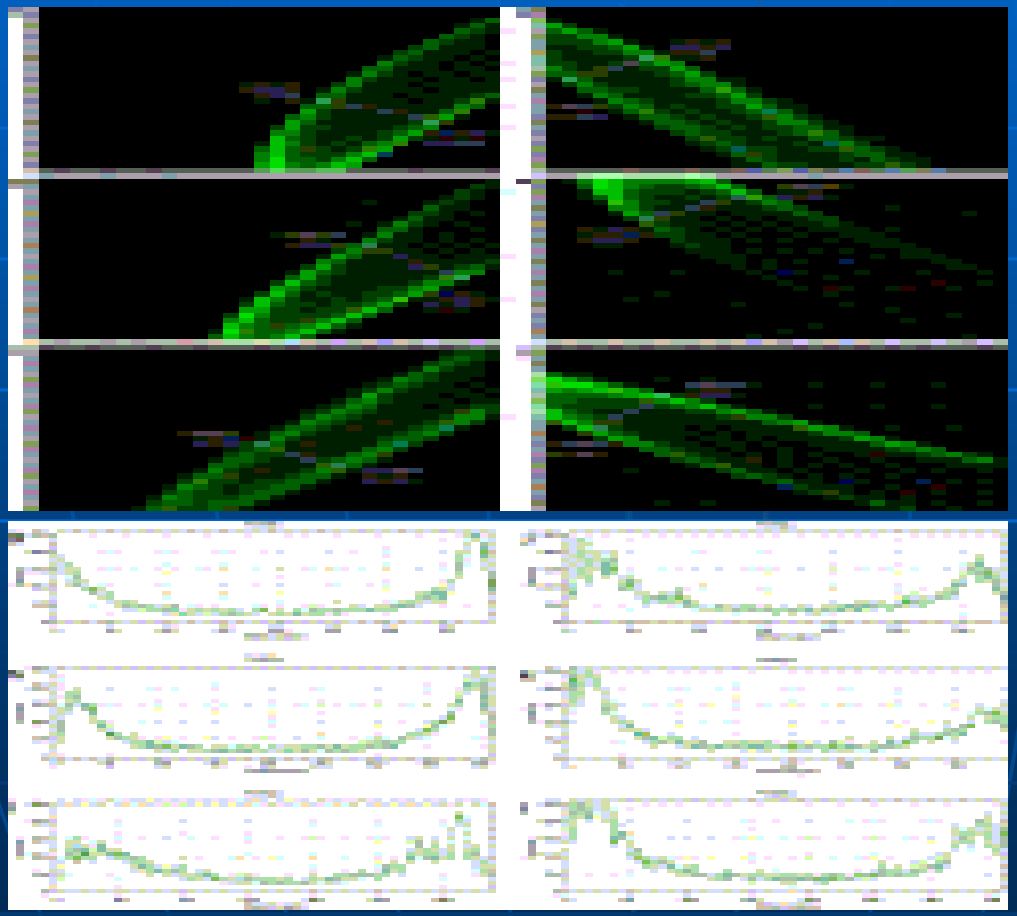
experiment

control

a b c

The samples were germinated beforehand in bidistilated water. a – time of action is 0 minutes, b – time of action is 30 minutes, c – time of action is– 60 minutes. Temperature T=23 ^{0}C.

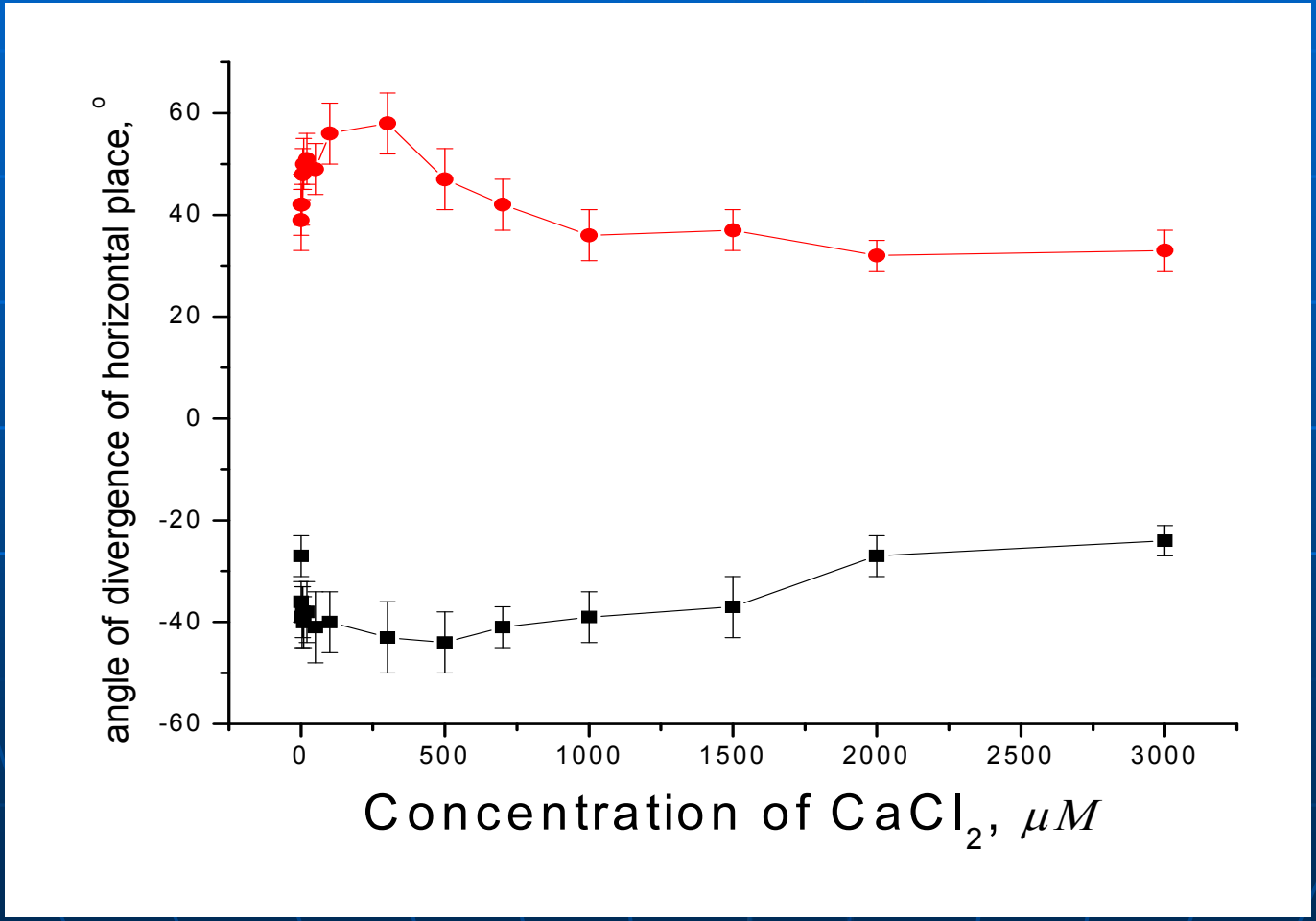
Cress roots after 30 minutes (a and c) and 1 hour (b and d) of gravistimulation in SMF (a and d) and in CMF (c and d).



Dependence of GTR on Ca^{2+} ions concentration

- Ca^{2+} is one of most biologically active ions. So the GTR of cress had to depend on its concentration. We studied the GTR dependence of cress on Ca^{2+} concentration both for SMF and CMF with alternative component tuned to the cyclotron frequency of Ca^{2+} ions. The results are shown on the next figure.
- It is seen from these curves that GTR not only changed its sign in CMF but also essentially expanded in CMF. This fact means that the region of activation of Ca^{2+} ions is expanded and its action we can see at smaller concentration of Ca^{2+}.

The dependence of GTR of cress roots on concentration of $CaCl_2$ in the water solution in which we germinated cress roots. The upper curve is the curve obtained in SMF; the down curve is obtained in CMF.



Model of GTR in CMF and SMF.
The distribution of amiloplasts in statocytes after 15,30 and 60 minutes gravistimulation in CMF and SMF

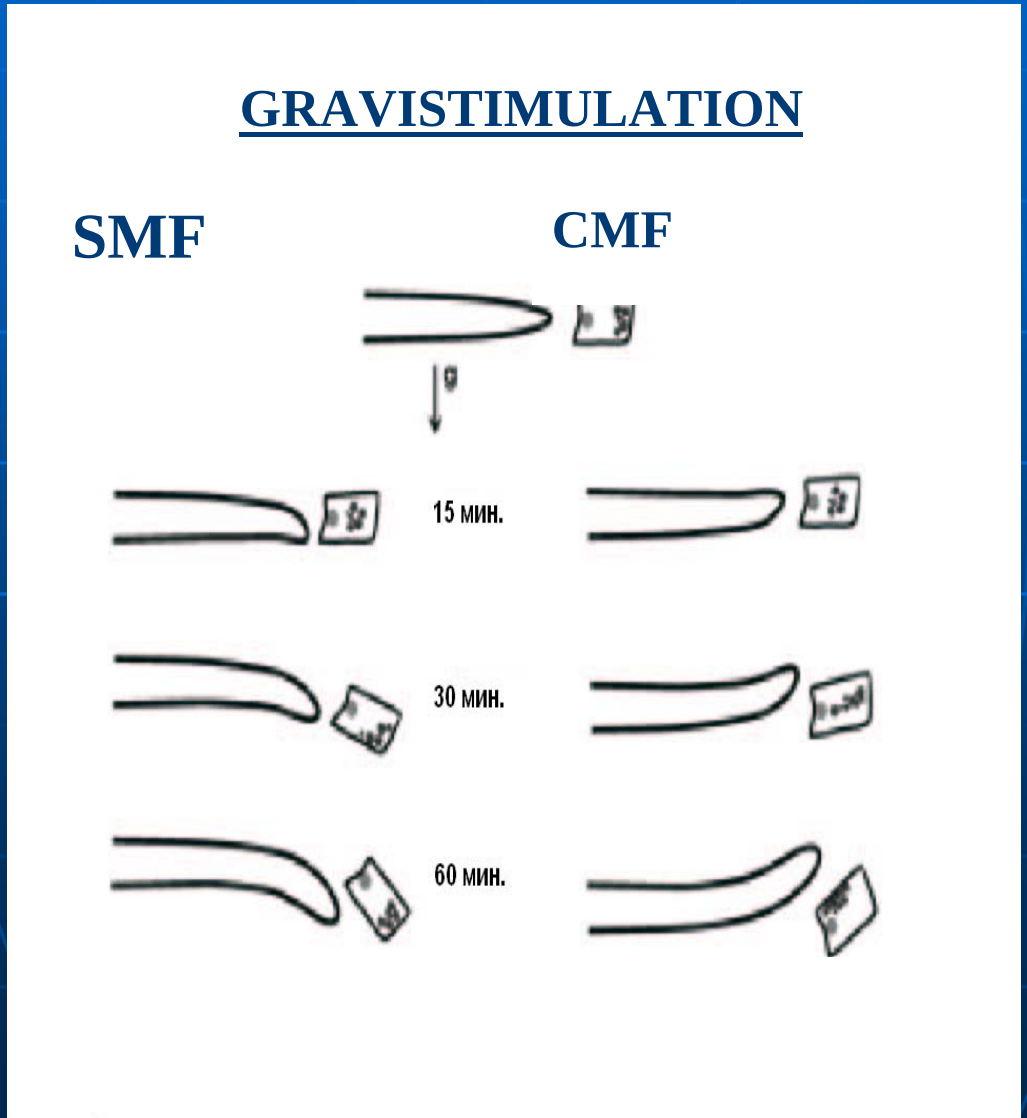


Table 1 . Intensity of fluorescence of Ca^{2+} ions, connected with the specific fluorescence indicator fluo-4 after 10 minutes of gravistimulation

Conditions under which the gravistimulation is treated	The zone of distal prolongation		Environment for germination	
			water	Water solution of $CaCl_2$
SMF	The first part	up	116 ± 3	150 ± 2
		down	184 ± 5	231 ± 3
	The second part	up	131± 2	72 ± 1
		down	195 ± 3	221 ± 3
CMF	The first part	Up	155 ± 4	233 ± 3
		Down	116 ± 2	92 ± 3

Table 2 . Intensity of fluorescence of Ca^{2+} ions, connected with the specific fluorescence indicator fluo-4 after 20 minutes of gravistimulation

Conditions under which the gravistimulation is treated	The zone of distal prolongation		Environment for germination	
			water	Water solution of $CaCl_2$
SMF	The first part	up	116 ± 3	150 ± 2
		down	184 ± 5	231 ± 3
	The second part	up	131± 2	72 ± 1
		down	195 ± 3	221 ± 3
CMF	The first part	Up	155 ± 4	233 ± 3
		Down	116 ± 2	92 ± 3
	The second part	Up	159 ± 4	194 ± 3
		down	101± 2	128 ± 2

Table 3 . Intensity of fluorescence of Ca^{2+} ions, connected with the specific fluorescence indicator fluo-4 after 30 minutes of gravistimulation

under which the gravistimulation is treated	The zone of distal prolongation		Environment f0r germination	
			water	Water solution of $CaCl_2$
SMF	Вода с хлористым кальцием	верх	119 ± 2	161 ± 3
		низ	146± 4	215 ± 3
	The second part	верх	93 ± 2	119 ± 2
		низ	139 ± 3	214± 3
CMF	The first part	верх	187 ± 3	228± 3
		низ	112 ± 2	170± 2
	The second part	верх	150 ± 4	202 ± 3
		низ	79 ± 2	127 ± 2

CONCLUSIONS ABOUT Ca^{2+}

- 1.It was shown that the changing of GTR sign in CMF leaded for the changing of Ca^{2+} ions distribution in the roots cells, exactly to the increasing of Ca^{2+} ions in the upper part of root.
- 2. The increasing of the initial concentration of Ca^{2+} ions leads to the increasing of roots curvature both in SMF and CMF, though the gravitropic reaction has the contrary sigh in CMF and SMF.
- 3. It was shown that GTR dependence on Ca^{2+} ions was nonlinear both in SMF and CMF. It has a maximum at certain Ca^{2+} ions concentration.

THE BASE OF THE PART OF THE WORK

- Burlakova E.B. (N. Emmanuelle Institute of biological and biochemical physics RAS, Moscow) revealed the new and very interesting phenomenon. Very little concentration of chemical substances were found to influence on the biological object.
- The magnitude of acting concentration is 10^{-10} – 10^{-17} mol/l.
- This phenomenon is investigated now very intensively. The nature of the action is not clear now. But the potential possibility of its using in pharmacy makes more and more investigators to devote their works to the theme. The problem is the part of nanobiophysics.

THE BASE OF THE PART OF THE WORK

- In 1986 Bogatina N.I.(B. Verkin Institute for Low Temperature Physics & Engineering) published the work devoted to the analogies of gravitational, magnetic and electrical fields effects on the biological objects.
- The main idea of that work was the estimation of concentration changes of active ions under the conditions of the threshold magnetic field, gravitational field and electrical field. This changes are proportional to exp(-E/kT). Here E is the energy of the corresponding field, T is the temperature, k is the Boltsman constant. For the threshold fields these changes magnitudes are of about 10^{-17} – 10^{-18} from the initial magnitude of active ions. But just the same concentration changes of auxin leads to the growing plants effects observed.

Work's purposes

- Work's purposes are
- To investigate gravitropic reaction (GTR) changes of cress roots after the previous exposition during 5 hours in the 1 nanomol/l solution of N-1-Naphthylphthalamic acid (NPA) both in static magnetic field (SMF) and in combined magnetic field (CMF), alternative component of which is adjusted to the cyclotron frequency of Ca^{+2} ions. The time of SMF and CMF action was 0.5, 1 and 24 hours.
- To investigate GTR changes of cress roots after the previous exposition during 30 minutes in the 1 nanomol/l solution of NPA both in SMF and in CMF, alternative component of which is adjusted to the cyclotron frequency of NPA^{-} ions. The time of magnetic field action was 0.5, 1, 2 and 48 hours.
- The comparison of results obtained.

RESULTS AND DISCUSSIONS

- **We can see very well from these figures, that the effect of the 5 hours previous action of NPA show no difference between the samples in SMF and CMF, alternative component of which is adjusted to Ca^{2+} ion cyclotron frequency (fig.4). This result show that the previous 5 hour processing in NPA solution put an end to effects observed before (positive gravitropism in SMF and negative gravitropism in CMF, alternative component of which is adjusted to Ca^{2+} ion cyclotron frequency). 1, 2 and 3 hour previous germination in NPA doesn't on GTR both in SMF and CMF.**
- **On the contrary the samples germinated during 30 min in NPA of the same concentration (1nanomol/l) in SMF don't show the increasing of GTR while in CMF, alternative component of which is adjusted to NPA^- ion cyclotron frequency, show the disappearance of any GTR (positive or negative).**
- **GTR both in SMF and CMF , alternative component of which is adjusted to H^+ ion cyclotron frequency, after 30 minutes germination in NPA is positive and doesn't differ in CMF and SMF.**

COMPARISON OF RESULTS AFTER 5-HOURS EXPOSITION IN NPA SOLUTION IN CMF WITH ALTERNATIVE FIELD COMPONENT ADJUSTED TO CYCLOTRON FREQUENCY OF Ca^{+2} IONS WITH THE CONTROL SAMPLES EXPOSED IN SMF

CMF 30 min

CMF 1 h

CMF 24 h

SMF 30 min

SMF 1 h

SMF 24 h

COMPARISON OF RESULTS AFTER 30-MINUTES EXPOSITION IN NPA SOLUTION IN CMF WITH ALTERNATIVE FIELD COMPONENT ADJUSTED TO CYCLOTRON FREQUENCY OF NPA$^-$IONS WITH THE CONTROL SAMPLES EXPOSED IN SMF

CMF 30 min.

CMF 1 h.

CMF 2 h.

CMF 48 h.

SMF 30 min.

SMF 1 h.

SMF 2 h.

SMF 48 h.

CONCLUSIONS OF THIS PART OF THE WORK

- After 5-hours exposition of cress roots in NPA the effect of gravistimulation disappears in CMF with the alternative component is adjusted to the cyclotron frequency of Ca^{2+} and in SMF. NPA is proposed to block auxine transport absolutely.
- Very short exposition of cress roots in NPA also leads to the disappearance of gravistimulation effect in CMF with the alternative component adjusted to the cyclotron frequency of NPA^{+} ions.
- So the following conclusions can de made:
- we can activate the biologically active compounds by means of CMF;
- the effect of CMF with the alternative component that is adjusted to the cyclotron frequency of biologically active ion is analogous to adding of very small dose of this compound.

THANK YOU FOR ATTENTION