MODELING OF COMBINED EFFECT OF ELECTROMAGNETIC RADIATION OF LOW INTENSITY AND BIOLOGICALLY ACTIVE SUBSTANCES AT BIOLOGICAL SYSTEMS

Rogacheva Svetlana M.[1,2], Gladkih S.A.[2], Artamonova Y.V.[1]

[1]Saratov State Technical University, Saratov, Russia,

[2] Saratov Military Institute of Biological and Chemical Safety, Saratov, Russia

It is known:

- Weak electromagnetic radiation of extremely high frequencies is known to cause unusually large effects in living systems of different organization levels.
- The first targets of the EMR effect are the water component of the systems and cell membranes.
- In spite of high ability of water to absorb EMR the waves of the definite ”resonant” frequencies deeply penetrate into the biological fluids and cause the biological response. Such property of water is explained by its cluster structure.

The aim

- To study the diapason of EMR 100-200 GHz in order to find new biologically effective frequencies.
- To study the isolated and combined effect of microwaves and biologically active substanses at biological systems.

MODEL SYSTEMS:

Infusorians *Paramecium caudatum*

Erythrocytes

Microwaves:

100 - 200 GHz

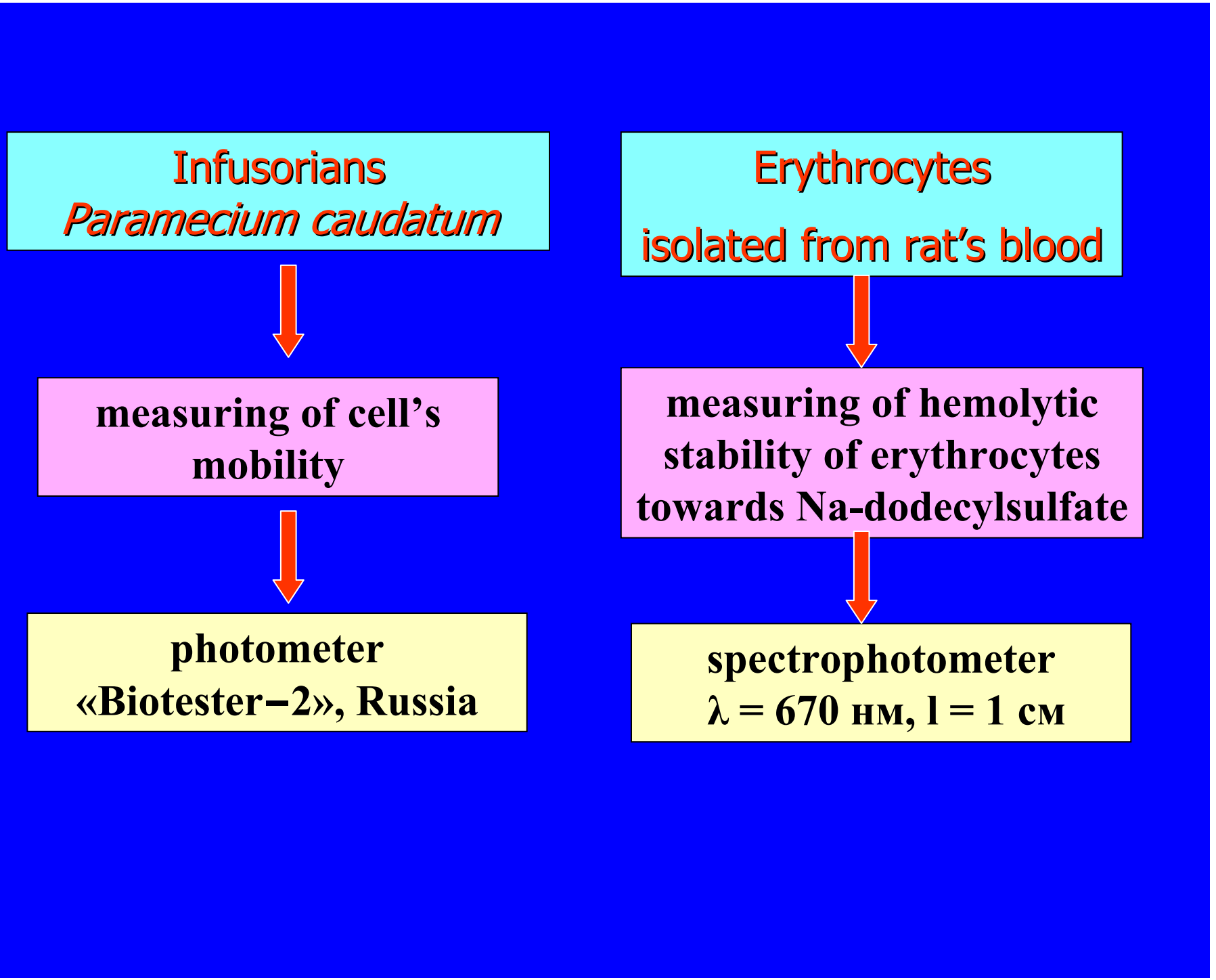
(sub millimeter diapason)

of low intensity

(10 μW/cm2)

Biologically active substances with opposite effect at water structure:

- nicotine - destabilizing
- metronidazole - stabilizing


Infusorians
Paramecium caudatum
measuring of cell's mobility
photometer «Biotester–2», Russia
Erythrocytes
isolated from rat's blood
measuring of hemolytic stability of erythrocytes towards Na-dodecylsulfate
spectrophotometer
λ = 670 нм, l = 1 см

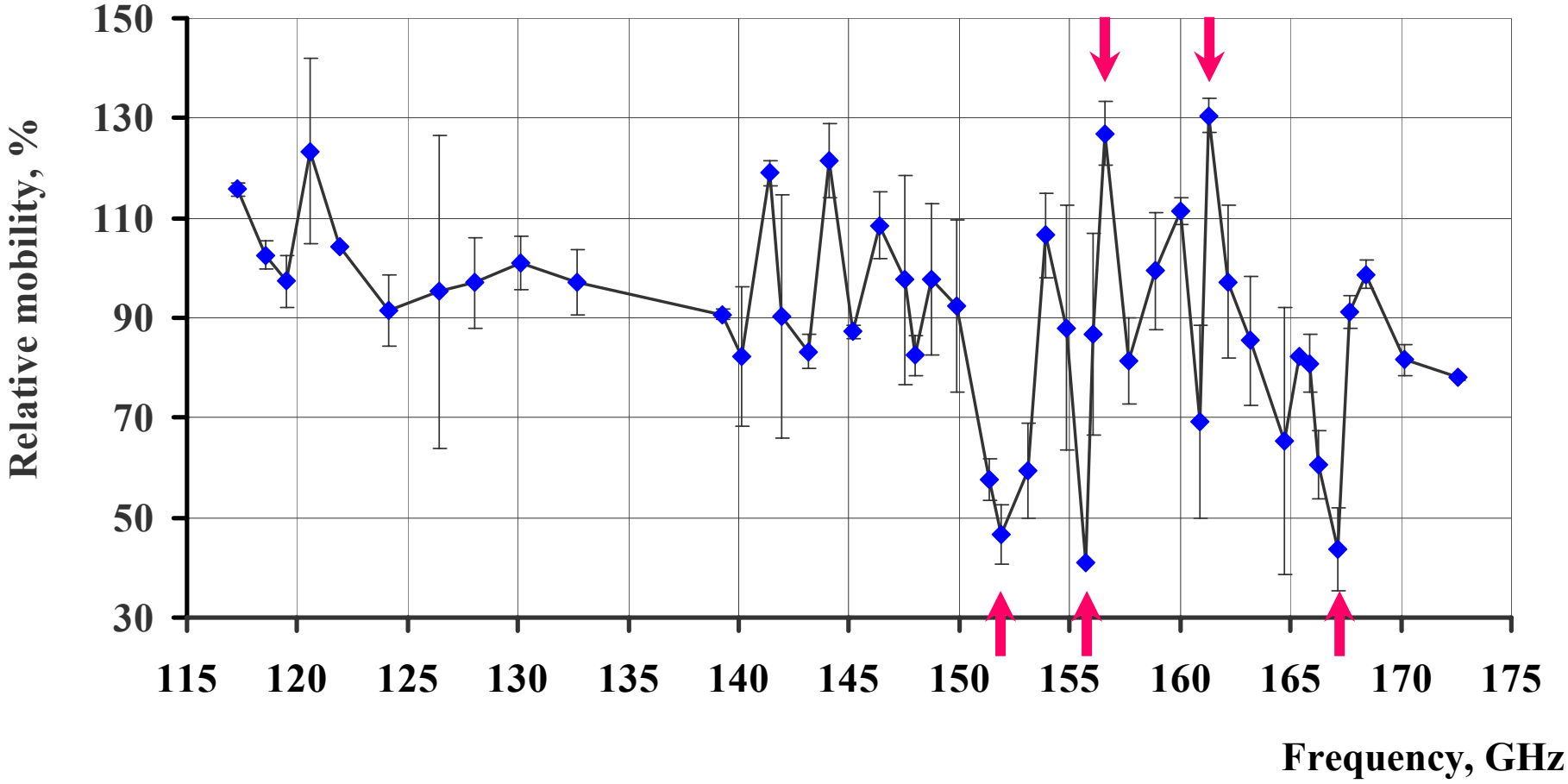


Fig.1. Dependence of Infusorian's mobility on the effect of EMR of different frequency. The mobility of cells without EMR effect is 100%

The time of irradiation of the cells – 10 min.

Table 1. Relative mobility of Infusorians dependent on the concentration of nicotine and incubation period

Nicotine concentration, mol/l	Relative mobility of Infusorians (%) at different exposition (min)			
	10	20	30	40
контроль	67.7 ± 3.6	76.0 ± 4.5	72.8 ± 6.0	71.2 ± 3.4
10^{-4}	105.7 ± 5.1	111.8 ± 1.9	112.1 ± 2.1	106.9 ± 0.2
10^{-5}	63.4 ± 5.9	58.0 ± 0.8	55.3 ± 8.0	62.4 ± 4.5
10^{-6}	52.3 ± 5.6	57.3 ± 3.4	68.2 ± 8.7	62.4 ± 0.9
10^{-7}	67.5 ± 7.6	72.3 ± 6.5	78.6 ± 9.3	65.1 ± 0.1
10^{-8}	60.2 ± 0.2	61.2 ± 4.0	54.6 ± 6.8	53.2 ± 0.6
10^{-9}	91.2 ± 3.9	186.0 ± 19.0	188.4 ± 14.6	176.6 ± 20.3
10^{-10}	86.3 ± 7.5	98.8 ± 0.1	76.4 ± 5.2	88.0 ± 1.4
10^{-11}	83.2 ± 6.7	78.3 ± 6.4	71.8 ± 1.3	54.1 ± 3.6
10^{-12}	76.6 ± 8.4	76.7 ± 14.3	73.7 ± 11.4	73.4 ± 5.8
10^{-13}	66.3 ± 4.1	68.9 ± 11.2	62.7 ± 8.9	62.0 ± 21.2
10^{-14}	64.7 ± 3.5	75.0 ± 3.6	73.8 ± 5.4	71.7 ± 1.4
10^{-15}	68.3 ± 9.3	74.5 ± 11.2	70.0 ± 4.4	69.9 ± 6.7

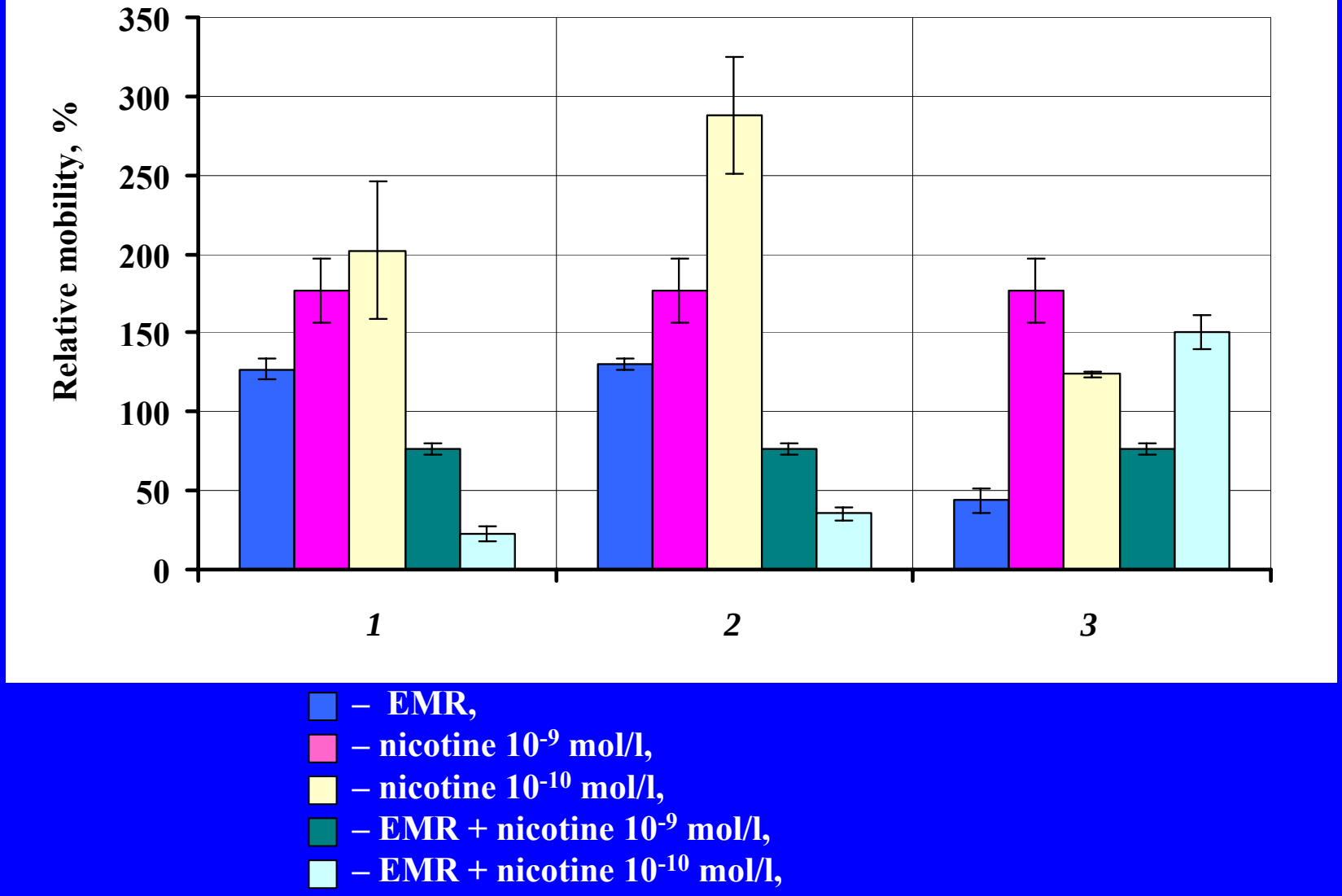
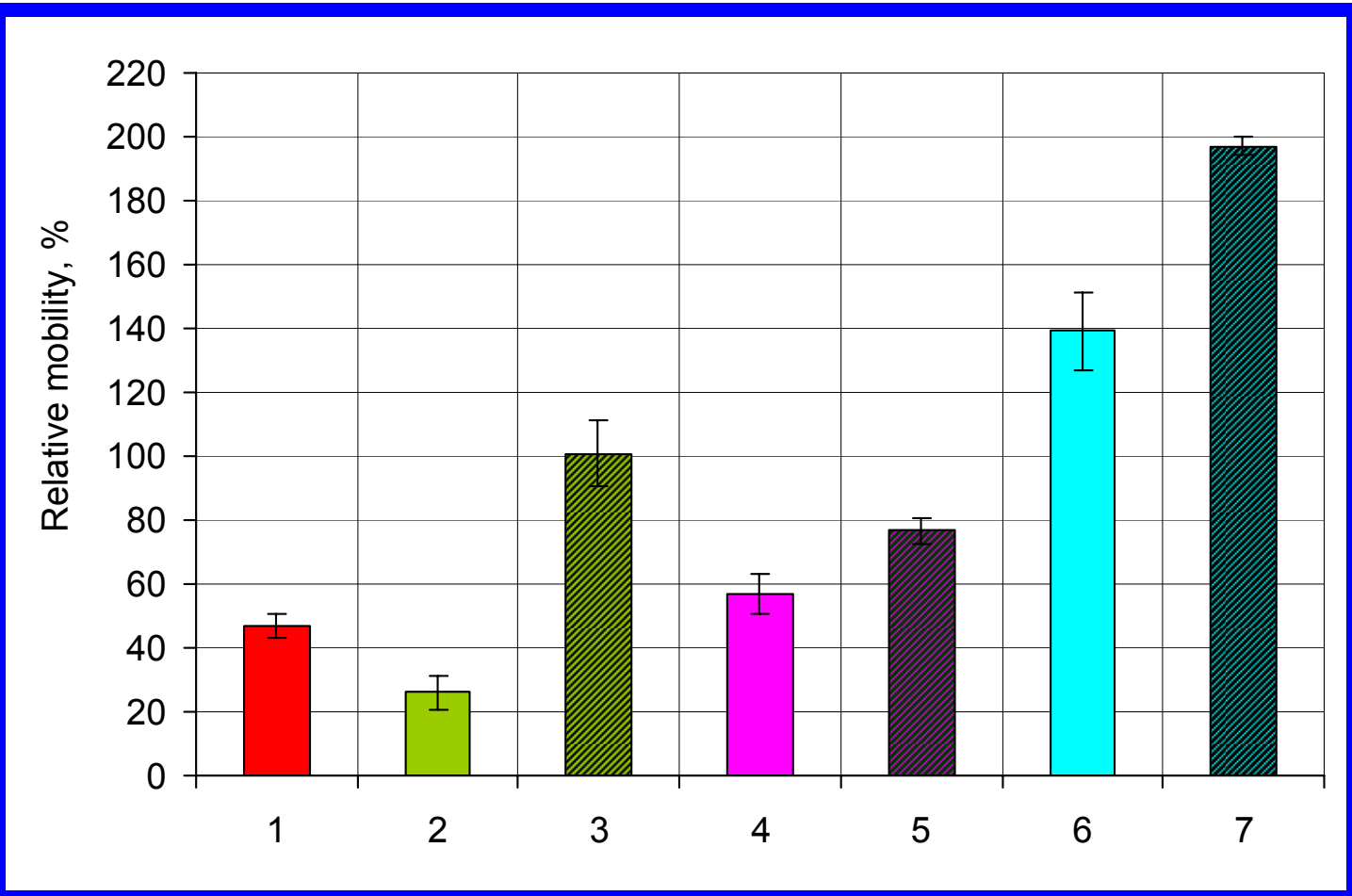


Fig.2. Relative mobility of Infusorians dependent on isolated and combined with nicotine effect of EMR at frequencies: *1* – 156.6 GHz, *2* – 161.3 GHz, *3* – 167.1. GHz. The mobility of cells without effect is 100%



1 - EMR 167.1 GHz;
2 – metronidazole (10^{-5} mol/l); **3** – 167.1 GHz + metronidazole (10^{-5} mol/l);
4 - metronidazole (10^{-8} mol/l); **5** - 167.1 GHz + metronidazole (10^{-8} mol/l);
6 - metronidazole (10^{-9} mol/l); **7** - 167.1 GHz + metronidazole (10^{-9} mol/l);

Fig.4. Relative mobility of Infusorians dependent on the effect.
Mobility of cells without effect is 100%

Table 2. Relative percent of hemolysis of erythrocytes under the action of nicotine and EMR

EMR, GHz	Relative percent of hemolysis				
	Without nicotine	Nicotine 10^{-5} mol/l		Nicotine 10^{-6} mol/l	
		isolated	Combined with EMR	isolated	Combined with EMR
151.8	1.33 ± 0.19	1.21 ± 0.19	1.75 ± 0.76	0.92 ± 0.14	2.00 ± 0.25
155.7	0.57 ± 0.08	1.03 ± 0.09	0.65 ± 0.16	0.86 ± 0.12	0.86 ± 0.12
156.6	1.11 ± 0.17	0.97 ± 0.21	1.38 ± 0.24	0.95 ± 0.20	1.35 ± 0.23
161.3	0.94 ± 0.13	1.00 ± 0.08	1.56 ± 0.32	1.03 ± 0.13	1.33 ± 0.02
167.1	0.92 ±0.20	1.22 ± 0.21	1.16 ± 0.24	0.92 ± 0.07	1.00 ± 0.19

Comparison with EMR 65 GHz

Table 3 - The number of non-hemolised erythrocytes

Probe	The number of non - hemolised erythrocytes, %
Control	98,5±10,4
Metronidazole (10^{-7} mol/l)	84,8±5,6
EMR (65 ГГц)	36,9±4,2
EMR + metronidazole	67,3±5,4

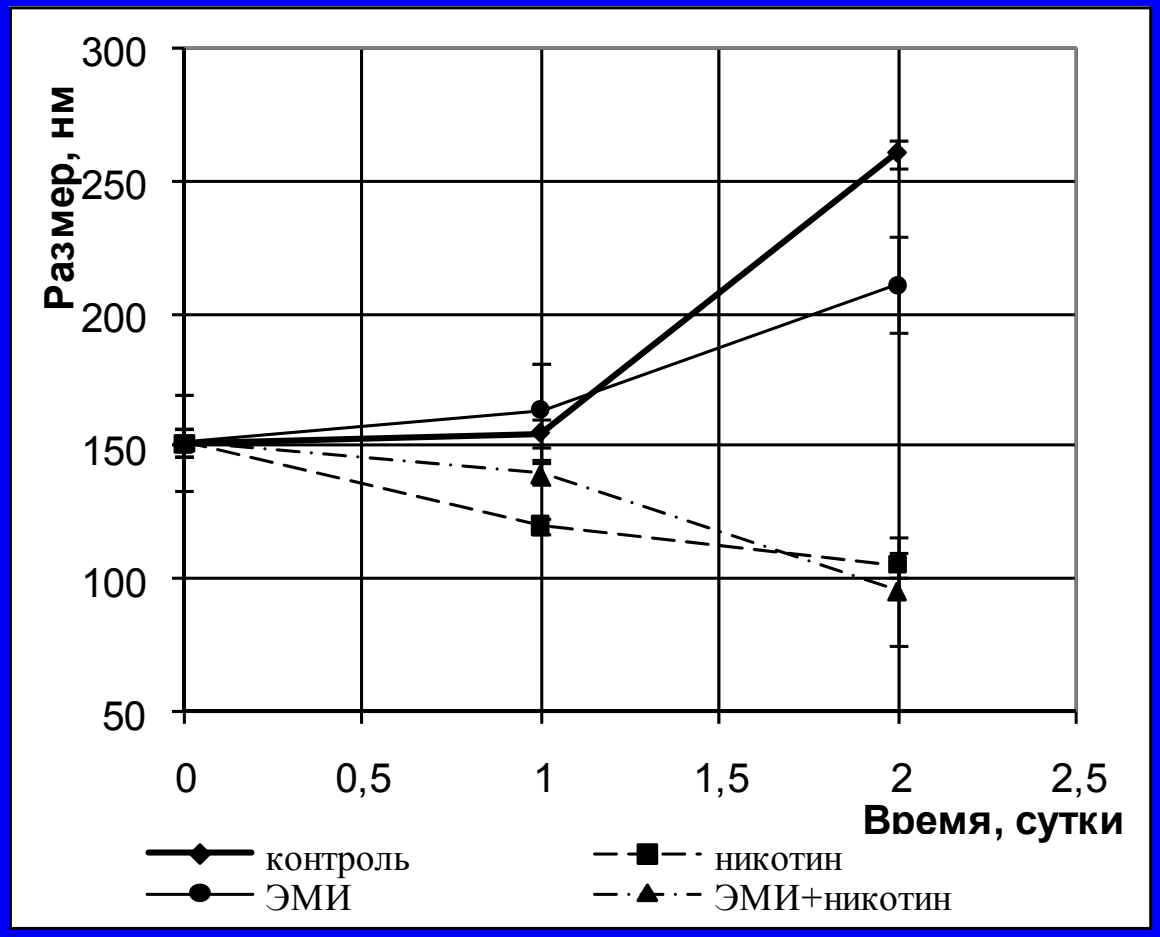


Fig.5. Changing of the sizes of nanoparticle aggregates under the action of EMR (65 GHz) and nicotine

Conclusions

- The using of the two model systems that allow registering the structure-functional changes in the cell membranes as a result of reorganization of the hydrogen-bond networks of subsurface water helped us to discover new resonant frequencies in unstudied diapason of EMR.

- The combined effect of EMR at the resonant frequencies and biologically active substances in low concentrations depends on the influence of the compound at the water structure.

- We suppose that EMR 167.1 GHz is biologically effective and may compensate the negative influence of the toxic substances at an organism.

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Thanks
for your attention!