5. Prato F. S. Light-dependent and -independent behavioural effects of extremely low frequency (ELF) magnetic fields in a land snail are consistent with a parametric resonance mechanism (PRM) / F. S. Prato, M. Kavaliers, A. P. Cullen [et al.] // Bioelectromagnetics. – 1997. – Vol. 18. – P. 284–291.
6. Lohmann K. J. Lunar-modulated geomagnetic orientation by a marine mollusk / K. J. Lohmann, A. O. D. Willows // Science. – 1987. – Vol. 235. – P. 331–334.
7. Маркель А. Л. К оценке основных характеристик поведения крыс в тесте «открытое поле» / А. Л. Маркель // Журнал высшей нервной деятельности им. И. П. Павлова. – 1981. – Т. 31, № 2. – С. 301–307.
8. Котельников А. В. Характеристика эстрального цикла белых крыс на разных этапах онтогенеза при введении витамина Е / А. В. Котельников, С. В. Котельникова // Вестник Астраханского государственного технического университета. – 2005. – № 3 (26). – С. 215–218.
9. Темур’янц Н. А., Вишневський В. Г., Костюк О. С., Макєєв В. Б. Патент Україна №48094, Бюл. №5. 2010.
10. Василенко А. М. Корреляция болевой чувствительности и гуморального иммунного ответа у мышей при терמораздрожении / А. М. Василенко, О. Г. Яновский, О. В. Коптелев // Бюлл. экспер. мед. – 1995. – Т. 4. – С. 405–408.
11. Prato F. S. Extremely low frequency magnetic fields can either increase or decrease analgaesia in the land snail depending on field and light conditions / F. S. Prato, M. Kavaliers, A. W. Thomas // Bioelectromagnetics. – 2000. – Vol. 21. – P. 287–301.
12. Del Seppia C. Exposure to a hypogeomagnetic field or to oscillating magnetic fields similarly reduce stress–induced analgesia in C57 male mice / C. Del Seppia, P. Luschi, S. Ghione [et al.] // Life Sci. – 2000. – Vol. 66, Is.14. – P. 1299–1306.
13. Choleris E. Shielding, but not zeroing of the ambient magnetic field reduces stress–induced analgesia in mice / E. Choleris, Seppia Del, A. W. Thomas [et al.] // Proceedings. Biological sciences. The Royal Society. – 2002. – Vol. 269. – P. 193–201.
14. Welker H. A. Effects of an artificial magnetic field on the serotonin N–acetyltransferesa activity and melatonin content of the rat pineal gland / H. A. Welker, P. Semm, R. P. Willing [et al.] // Exp. Brain Res. – 1983. – Vol. 50. – P. 426–432.
15. Yaga K. Pineal sensitivity to pulsed static magnetic fields changes during the photoperiod / K. Yaga, R. J. Reiter, L. C. Manchester [et al.] // Brain Res. Bull. – 1993. – Vol. 30. – P. 153–156.
16. Макеев В. Б. Экспериментальное исследование физиологического действия ЭМП инфранизкой частоты: автореф. дисс. на соискание ученой степени канд. биол. наук / В. Б. Макеев. – Симферополь, 1979. – 25 с.

DEPENDENCE OF THE EFFECTIVENESS OF THE MODERATE FERROMAGNETIC SCREENING ON THE BIOLOGICAL OBJECTS CHARACTERISTICS

Temuryants N. A., Tumanyants K. N., Chuyan E. N., Yarmolyuk N. S.

V. I. Vernadsky Crimean Federal University, Simferopol, Russian Federation
E-mail: timur328@gmail.com

For the studying of the mechanisms of the implementation of the connections between the Sun and the Earth, studies of the biological efficiency of hypo magnetic field (HMF) have a great potential; it can be achieved both by the screening be different materials and compensation through the Helmholtz rings. But if during the ferromagnetic screening (FMS) and electromagnetic screening, the static magnetic field and the alternating magnetic field of various frequency ranges decrease, the Helmholtz rings reduce only the static magnetic field of the Earth. Unfortunately, in many studies, the

results of these two distinct kinds of influence are discussed together. For example, in the last comprehensive review devoted to the biological effects of HMF, the results of these two different influences of different lengths have been combined into one table [1]. It is not a coincidence that many authors notice the low reproducibility of the HMF effects [1]. The reason for the irreproducibility of the results of these kinds of studies might be their dependence on not only the measures of influencing factor, but also the characteristics of the biological objects used in the experiment. The analysis of the results of the multiyear study of the effects of the moderate FMS that we conducted allowed us to distinguish the characteristics of biological objects that influence the results of the experiments [2].

It was discovered that different animals have different sensitivity to FMS. The level of sensitivity of Mollusca revealed was higher than that of mice and rats. Thus, all animals develop 3-phase changes in nociception, but all the stages of these changes among mice are developed faster and they are of less obvious.

The animals are the most sensitive to FMS during the stage of fetal development.

The sensitivity to FMS depends on a season. Mollusca have the most distinct changes nociception under the influence of FMS in spring and autumn. Anti-nociceptive effect of FMS during these seasons is higher by 94.5 % and 72.4 % respectively than the one during the period of winter. However, in summer, the analgesia registered is 3 % less distinct than it is in winter.

The efficiency of FMS depends on the animals' sex. FMS lead to the oppression of rats' sexual behaviour that was studied in the test "barrier", that is more distinct among males. The level of its reduction among females depends on the phase of the estrous cycle of an animal. Its most significant reduction was fixed among females that were at the diestrus stage; the least reduction was observed at the stage of proestrus.

The dependencies of the biological influence of the moderate FMS that we discovered coincide with the data revealed by the other authors who study these patterns under the influence of electromagnetic factors of other measures.

***Keywords*:** ferromagnetic shielding, nociception, sexual behavior, biological objects, mollusks, mice, rats.

References

1. Binhi V. N., Prato F.S. Biological effects of the hypomagnetic field: An analytical review of experiments and theories, *PLoS One*., 12, **6**, 1 (2017).
2. Temuryants N.A., Chuyan E.N., Kostyuk A.S. [et al.] *The Effects of the Weak Electromagnetic Influences among Invertebrate Animals (The Regeneration of Planarian, The Nociception of Mollusca)*, 303 (Simferopol: DIAIPI., 2012).
3. *European Convention for the Protection of Vertebrates Used for Experiments or for Other Scientific Purposes*, Strasbourg, 18 March 1986, Chapter III, Article 6.
4. Prato F. S., Kavaliers M., Carson J. J. L. Behavioural evidence that magnetic field effects in the land snail, *Cepaea nemoralis*, might not depends on magnetite or induced electric currents, *Bioelectromagnetic*, **17,** 123 (1996).
5. Prato F. S., Kavaliers M., Cullen A. P. [et al.] Light-dependent and -independent behavioural effects of extremely low frequency (ELF) magnetic fields in a land snail are consistent with a parametric resonance mechanism (PRM), *Bioelectromagnetics*, **18,** 284 (1997).
6. Lohmann K. J., Willows A. O. D. Lunar-modulated geomagnetic orientation by a marine mollusk, *Science*, **235**, 331 (1987).

7. Markel A. L. To the assessment of the main characteristics of the behavior of rats in the "open field" test, *Journal of Higher Nervous Activity I. P. Pavlova*, 31, **2**, 301 (1981).
8. Kotelnikov A. V., Kotelnikova S. V. Characterization of the estrous cycle of white rats at different stages of ontogenesis with the introduction of vitamin E, *Vestnik of Astrakhan State Technical University*, **3 (26)**, 215 (2005).
9. Temur'yants N. A., Vishnevsky V. G., Kostyuk O. S., Mak'yev V. B. Patent Ukraine №48094, Bul. №5. 2010.
10. Vasilenko A. M., Yanovsky O. G., Koptelev O. V. Correlation of pain sensitivity and humoral immune response in mice with thermo-irritation, *Bull. expert. Honey*, **4**, 405 (1995).
11. Prato F. S., Kavaliers M., Thomas A. W. Extremely low frequency magnetic fields can either increase or decrease analgaesia in the land snail depending on field and light conditions, *Bioelectromagnetics*, **21,** 287 (2000).
12. Del Seppia C., Luschi P., Ghione S. [et al.] Exposure to a hypogeomagnetic field or to oscillating magnetic fields similarly reduce stress–induced analgesia in C57 male mice, *Life Sci*., 66, **14**, 1299 (2000).
13. Choleris E., Del Seppia, Thomas A. W. [et al.] Shielding, but not zeroing of the ambient magnetic field reduces stress–induced analgesia in mice, *Proceedings. Biological sciences. The Royal Society*, **269**, 193 (2002).
14. Welker H. A., Semm P., Willing R. P. [et al.] Effects of an artificial magnetic field on the serotonin N–acetyltransferesa activity and melatonin content of the rat pineal gland, *Exp. Brain Res.*, **50**, 426 (1983).
15. Yaga K., Reiter R. J., Manchester L. C. [et al.] Pineal sensitivity to pulsed static magnetic fields changes during the photoperiod, *Brain Res. Bull*., **30**, 153 (1993).
16. Makeev V. B. *Experimental study of the physiological effect of EMF of infralow frequency: author's abstract. diss. for the academic degree of Cand. Biol. Sciences,* 25 (Simferopol, 1979).