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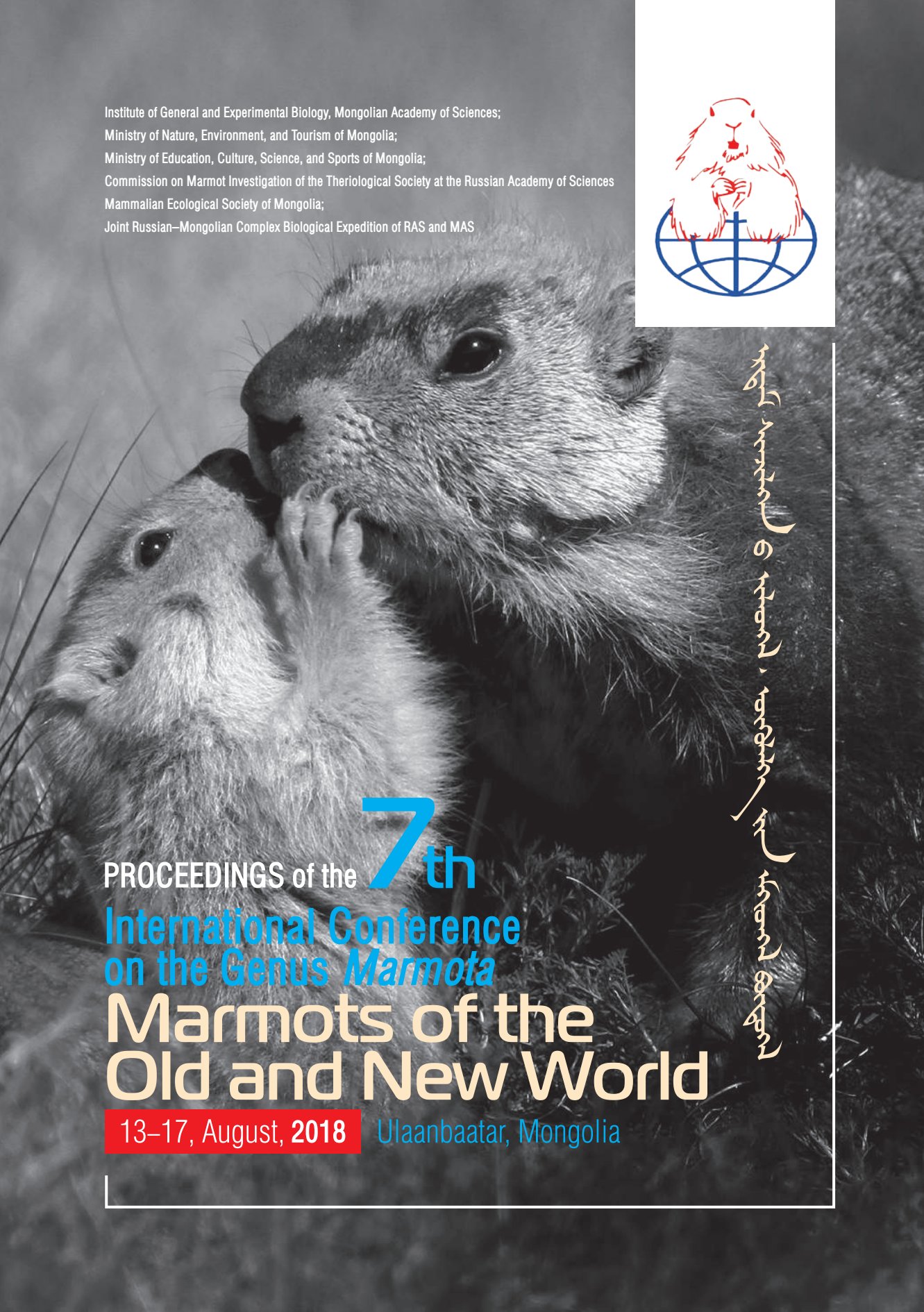

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CHEMICAL BASIS OF STABLE ELEMENTS FOR THE BIOLOGICAL SIGNAL FIELD OF MARMOTS

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Abstract. Chemical substances of the skin glands secretion products, of excrements and their decomposition products create the chemical basis of stable elements for the biological signal field of marmots. The chemical composition of the volatile substances that could be stable elements and form olfactory image of the territory inhabited by marmots is discussed. Uneven accumulation of these substances in the soil cover (related to the probability of leaving a scent trail by rodents) creates gradients of the biological signal field facilitating the orientation in the space for marmots.

The biological signal field (Naumov, 1971; Vanisova & Nikol'skii, 2013) is one of the main sources of information about the territory with resources on it. The traces of animal vital activity (burrows, paths, feces accumulations etc.) create an odor-visual image of the space and, left by many generations of Mammals, preserve and transmit information about the territory that organizes the use of space by each generation of animals.

The study conducted on the example of a steppe marmot colony *(Marmota bobak)* (Vanisova et al., 2016) was the first attempt to describe the chemical structure of the biological signal field of Mammals. Chemical analysis (by gas chromatography / mass spectrometry) of the topsoil samples (collected directly on the entrance to the central burrows, on the paths at 5 meters from them and at 30 meters from the central burrow holes away from the paths and butanes, where there are no visible traces of marmots' vital activity) showed the unevenness of the olfactory image of the marmots' family sectors. It is related to the probability of leaving a scent trail by marmots.

The quantitative content of volatile compounds in samples of the upper soil layer, taken from sites of the territory regularly visited by marmots (from the entrance to the burrow and from the paths; Me = 248,35 mkg/g, n = 19) statistically significantly (by the Mann-Whitney test, p = 0,046) exceeds their content in the background (Me = 143,56 mkg/g, n = 10), that marmots do not attend or attend episodically. Uneven accumulation of substances in the soil in the process of marmots' vital activity creates gradients of the olfactory biological signal field, facilitating the orientation of rodents in the territory of colony.

As part of the volatile fraction of the topsoil samples from family sectors cover of steppe marmot were found from 50 to 110 components per sample - chemical compounds, presumably carrying information in the context of the biological signal field formed by many generations of rodents. The chemical composition of samples is heterogeneous and characterized by the predominance of various classes of organic substances, that is probably connected with the presence of free fatty acids and their derivatives, as well as with the processes of their oxidation (Chloe & Min, 2006). The main classes of volatile components selected from the soil samples in the steppe marmot colony coincide with the main classes of volatile components of the mammalian skin glands secretion (Sokolov &

Stepanova, 1986): fatty acids, amines, hydrocarbons, ketones, alcohols, aldehydes, organosulfur compounds. Hydrocarbons, including normal alkanes, unsaturated hydrocarbons, branched hydrocarbons and aldehydes are the most common compounds found in all soil samples from the steppe marmot colony. Organosulfur compounds, amines and ketones are rare and their relative content in the samples is low.

The main source of chemical information left by marmots on the ground surface is probably the plantar gland, known in many species of Mammals (Sokolov, 1977; Ad'yaa, 1993; Mashkin & Baturin, 1993; Shubin & Spivakova, 1993). Other sources of chemical substances is secretion products of the jugal glands, left by marmots when marking the territory. Chemical analysis of samples of jugal glands secretion products of alpine marmot *(Marmota marmota)* (Bel, 1998) revealed mainly fatty acids and esters in various concentrations, alcohols and hydrocarbons, organosulfur compounds, ketones. Notably, the compounds characteristic for the secretion of the jugal glands of alpine marmot, and the compounds found in the soil cover of steppe marmot colony, belong to the general classes of substances.

An important constant source of the olfactory image in the marmot colony is latrines, located in depressions on the surface of butanes. The source of volatile substances here can be excrements and the products of their decomposition. 16 compounds were identified in the volatile fraction from a sample of fresh excrement of steppe marmot (Vanisova et al., 2016). Some components of the excrement were found in all soil samples, and their content in the samples from the entrance to the burrows and from the paths is slightly higher than content of these volatile substances in the samples from background. Probably there is a relatively stable group of substances in the accumulated over a long time the mass of excrements, that creates an odor image of the place of constant accumulation of excrements, performing the function of a stable element of the biological signal field.

Presumably, the substances (the skin glands secretion products, the excrements and products of their decomposition) interact with the soil cover, retaining, accumulate in it, creating a stable scent image of space. Because the volatile components left by Mammals on the substrate belong mainly to the same classes of substances, then we can assume that different parts of the territory smell the same, but with different intensity, forming gradients of the biological signal field. Herewith, there may be differences in the structure of the odor spectrum of volatile substances from different individuals, as shown on alpine marmot (Bel, 1998). The species differences probably also concern the structure of the olfactory spectrum – the ratio of the number of some chemical components and the loss / presence of one or other of them. Moreover, the chemical image of a Mammal's territory can be mediated by a species-specific microflora (Ushakova & Andreev, 1985; Sokolov & Ushakova, 1986).

Volatile substances, chemical traces of marmots, superimposed on the system of visible (optical) elements of the biological signal field, take part in creating a matrix of stable elements, supplementing and enhancing the visual image of the territory inhabited by marmots, form the odor-visual image of space. The creation and regular renewal of stable and less stable elements in the biological signaling field of marmots contributes to the accumulation and transfer of information about the territories with the resources located on it, necessary for each generation of these hibernating burrowing rodents.

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REFERENCES

Adiya Ya. 1993. Kozhnye zhelezy mongol'skogo surka [Skin glands of Mongolian marmot]. *Mezhdunarodnoe (5) Soveshchanie po surkam stran SNG (21-23 sentyabrya 1993 g., s. Gaidary, Ukraina). Tezisy dokladov* [5th International Conference on Marmots of CIS countries (21-23 September 1993, village Gaidar, Ukraine). Proc. rep.]. Moscow, Russian Academy of Sciences. p. 5.

Bel M.C. 1998. Le marquage jugal chez la marmotte alpine (*Marmota marmota*, Linné 1758): aspects éco-éthologiques et étude du système de communication chimigue. Thèse pour l'obtantion du diplôme de doctorat, soutenue le 23 Octobre 1998.

Chloe E., Min D.B. 2006. Mechanisms and factors for edible oil oxidation. Comprehensive reviews in food science and food safety. V.5. - P. 169-186.

Mashkin V.I., Baturin A.A.1993. *Surok Menzbira* [Menzbir marmot]. Kirov. 144 p.

Naumov N.P. 1971. Urovni organizatsii zhivoi materii i populyatsionnaya biologiya [Organization levels of living matter and population biology]. *Zhurnal obshchei biologii – [Biology Bulletin Reviews]*. V. 32. P. 651-666.

Shubin V.I., Spivakova L.V. 1993. Kozhnye zhelezy i zapakhovoe mechenie u surkov (*Marmota*, Sciurudae) [Skin glands and inguinal-marking in marmots (*Marmota*, Sciurudae)]. Selevinia. P. 69–80.

Sokolov V.E. 1977. Khimicheskaya kommunikatsiya mlekopitayushchikh [Chemical communication in mammals]. *Voprosy teriologii. Uspekhi sovremennoi teriologii* [Theriology Issues. Successes of modern Theriology]. Moscow, Nauka. P. 229-255.

Sokolov V.E., Stepanova L.V. 1986. Vidospetsifichny li kozhnye zhelezy – istochniki khimicheskikh signalov mlekopitayushchikh? [Are skin glands – the sources of chemical signals mammals – species specific?]. *Khimicheskaya kommunikatsiya zhivotnykh* [Chemical communication of animals]. Moscow, Nauka. P. 254-263.

Sokolov V.E., Ushakova N.A. 1986. Mikroflora i khimicheskaya kommunikatsiya zhivotnykh: nekotorye ekologicheskie aspekty [Microflora and chemical communication of animals: some ecological aspects]. *Khimicheskaya kommunikatsiya zhivotnykh* [Chemical communication of animals]. Moscow, Nauka. P. 263-272.

Ushakova N.A., Andreev L.V. 1985. Sposobnost' bol'shoi peschanki rasprostranyat' v pochve sporoobrazuyushchie bakterii i drugie mikroorganizmy [Great gerbil ability to distribute soil spore-forming bacteria and other microorganisms]. *IX Mezhdunarodnyi kollokvium po pochvennoi zoologii. Moskva, SSSR. Tezisy dokladov* [IX International Colloquium on Soil Zoology. Moscow, USSR. Proc. rep.]. Vilnius. P. 297.

Vanisova E.A., Nikol'skii A.A. 2013. Biological Signaling Field in Mammals (For 110th Anniversary of Professor N.P. Naumov). *Biology Bulletin Reviews.* V.3, №5. P. 335-346.