APIMONITORING ENVIRONMENTAL CONTAMINATIONS

G.V. Lomaev, T.G. Gabrichidze, N.V. Bondareva, N.V. Kozlovskaja,
E.N. Bajkova

The purpose of work is to show an opportunity of use of bees for diagnostics and the control of environmental contamination over an example of arsenic, iron and gipo- and hypermagnetic fields.

On change of physiological parameters of bees, presence in their organism and products of ability to live of heavy metals, connections of arsenic, radioactive nuclides and others pollutants it is possible to estimate ecological conditions in the given district, to track migration of an element in ecosystem and to estimate its influence on biological objects. The concept of apimonitoring as independent and effective making part of biomonitoring is developed by G.V. Lomaev and N.V. Bondareva.

Actually, apimonitoring in narrow sense includes: (a) supervision over a life of bees in conditions of possible pollution of an inhabitancy of beer family or group of beer families; and (b) sampling of products of ability to live of family and carrying out of chemical and analytical researches with the purpose of definition of physiological changes in a body of beer individuals and a chemical compound of honey, propolis, ambrosia, wax, a body of bees and other components entering into biosystem " beer family ". As the indicator of pollution of environment melliferous bees possess following features: cosmopolitan distribution, precise correlation to the certain site of district, display plasticity, simplicity of extraction and the account, settled way of life, a level of scrutiny in the toxicological attitude, an opportunity of training and others. The concept apmonitoring is formulated as follows: in controllable territory are placed apistations (groups of several beer families) behind which supervision are conducted and on a regular basis tests of products of ability to live for biophysical, chemical and physiological researches undertake, the given researches are carried out.

Bees, and also products of their ability to live (honey, wax, pollen of melliferous plants, ambrosia, propolis, royal jelly) comprise more than 30 chemical elements in structure of various connections. Concentration of some elements in fabrics and products of bees precisely correlates with their maintenance in an environment - ground, water, air, fabrics of plants. This circumstance allows to use bees and their products as indicators of a condition of environment. Besides just listed, some toxicants cause mutations and physiological deviations that it is possible to register the standard methods.

However till now are not carried out quantitative researches of bees as bioindicators; it is not established, the information on the maintenance pollutants in an environment, received is how much authentic at research of concentration of elements in a body of bees and products of beekeeping. There are no data about parameters of bees as biofilters of heavy metals, it is not enough data on accumulation (or dispersion) them in a chain ground, water, air → plant (nectar, pollen, propolis) → bees → wax, honey, royal jelly. It is important to accent that fact, that various pollutants are differently adsorbed (or are filtered) by parts of a trophic chain, since ground and finishing products of ability to live of bees. Results of apiminitoring are impossible without knowledge of the specified properties of elements of all circuit. Authors put before themselves a number of problems, for example:

- What background concentration of pollutant in products of ability to live of bees and its dependence on floristic structure of district, climatic and seasonal weather conditions?
- How the substance-pollutant in a body of bees during the process of ontogenesis of insects from an egg up to imago is distributed at background receipt of substance with a forage?
- How concentration of substance-pollutant in products and fabrics of bees (at different stages of ontogenesis) varies at its raised/lowered receipt in an organism?
- What filtering properties of bees and threshold concentration of pollutant, breaking physiological mechanisms of a biofiltration?
- What physiological, etological and morphological characteristics of bees are subject to undesirable changes under influence of this or that pollutant or technogenic physical influence?

In the report results of our researches private, but important for introduction apimonitoring in practice of problems are resulted.

1. Migration of arsenic on a circuit "ground - a product of ability to live of a bee".

2. Dynamics of iron in ontogenesis of bees in conditions of change of size of a geomagnetic field and a variation of concentration of an element in a forage.

The methodology of researches will be resulted at public performance. Below only brief results are stated.

Arsenic.

On results of supervision on experimental platforms the steadiest to pollution, i.e. there are perspective both as phytomeliorants for biological reclamation, and as the test-objects for carrying out of monitoring of sites of possible pollution of environment arsenic-containing connections: *Melilotus officinalis, Medicago falcate, Chamenerion angustifolium, Puccinellia distans, Achillea millefolium, Picris hieracioides.*

The same kinds of plants, not losing viability, accumulate in the biomass arsenic, withdrawing it from ground. It is necessary to note, that the listed grasses are nectariferous and polliniferous. It allows us to consider the specified kinds perspective as phytomeliorants in schemes biological reclamation, and as apitest-objects for carrying out of monitoring of sites of possible pollution of environment arsenic-containing as connections.

We had been received the data describing arsenic as cumulative poison at small concentration. So, at action of arsenic (calcium arsenate) on bees with concentration on 2, 1.5, 1 mg/l the death attacked 5-7 day. Till this period it has not been registered any lost bee. In control groups the death of bees at the initial stages was above, but not such mass.

The lead experiences testify to chronic toxic action of arsenic with concentration 1.6, 0.9, 0.4 mg/l. (Arsenic entered with a sugar syrup). Display etological reactions consists in reluctant consumption of a syrup with arsenic, and general more languid behaviour. Distinctive feature was the destruction of all bees in one day.

The given feature speaks that at environmental contamination by arsenic in small concentration, toxic effect to be shown through the certain period.

The analysis of action of arsenic in very low concentration on bees it was estimated by means of enzymes. As analyzed systems invertase KF 3.2.1.26 and catalase KF 1.11.1.6 enzymes are chosen. We receive following results. At concentration of 0.00268 mg/l decrease in activity of invertase on 312.3 %, in relation to the control is observed. It can be treated as positive arsenolytic effect as bees do not need to develop so a lot of the given enzyme. Though the syrup, given to bees, consists of saccharose which splits invertase. Its activity should increase many times over, that we and see in the control. At increase of concentration *As* in a syrup up to 0.0536 mg/l and 0.009 mg/l the increase in activity of enzyme approximately in 3 and 5 times accordingly is observed. Thus, by bees it is carried out the compensatory mechanism in reply to oppression of glycolysis. The doze of the maximal concentration (0.01198 mg/l), obviously causes a negative effect as activity of invertase enzyme again falls and makes a negative gain of 45 %. The organism of bees does not cope with such doze of arsenic. Probably insufficient mastering of monosugars and insufficient splitting disaccharides, and also the general toxic oppression.

Are investigated as the effects caused by action by arsenic on catalase.

Migration of arsenic is studied not in full. At very low concentration of arsenic in a syrup (up to 0.009 mg/l), it is filtered by bees. Its maintenance in a body of a bee increases repeatedly. In honey its concentration falls. At increase in receipt of arsenic (up to 0.01198 mg/l), this process is broken. Concentration of arsenic in a body of a bee noticeably falls, in honey, on the contrary increases. Hence, the finding of arsenic in honey depends more linearly on increase in its concentration in an environment, than in a body of a bee. Bees are an original barrier on a way of migration of arsenic from an environment in honey (probably and in other products of ability to live of bees). The given mechanism is broken at increase in receipt of arsenic. Similar "jump" was observed at measurement of activity of enzyme invertase.

Iron.

Are carried out researches of an exchange of iron and a mineralization of a ferromagnetic phase in an organism of bees. Properties of a magnetic material of bees are studied. Influence of external factors (artificial constant magnetic fields, the maintenance of iron in a forage) on processes of accumulation, distribution and a mineralization of iron in ontogenesis is analysed.

By results of researches are drawn following conclusions:

- Dynamics of the maintenance of iron in a body of bees at different stages of development is revealed. It is established, that accumulation of iron in an organism has non-uniform character: its basic quantity is acquired on 7 - 9 day from the moment of egg laying.

At adult individuals concentration of iron in a body on the average makes 80,36 - 174,33 mkg/g of dry substance. The maximal concentration is noted in pectoral muscles (162,61 - 368,87 mkg/g of dry substance), minimal - in finitenesses (16,52 - 29,25 mkg/g of dry substance).

Change of a geomagnetic field during development of a bee practically is not reflected in dynamics of a level of iron in fabrics of developing bees, in its distribution in an organism of imago and in the maintenance in products of ability to live.

In conditions of superfluous receipt of iron its concentration in fabrics raises at all stages of ontogenesis, distribution in an organism of imago varies. The level of iron most noticeably raises in abdomen segments (integument of abdomen); in pectoral muscles, on the contrary, it remains stable. The increase in the maintenance of iron in all products of bees in conditions of superfluous receipt of an element (especially - in honey) is noted and it has nonlinear character.

- In natural conditions formation of a ferromagnetic phase begins at a stage of a predoll (10 - 11 day from the moment of egg laying).

Magnetic field.

Hypergeomagnetic fields do not render appreciable influence on the beginning of formation of a magnetic material in ontogenesis of bees. However Hypogeomagnetic the field (indemnification of a field of the Earth) leads to a delay of biosynthesis of a magnetic material: occurrence of a ferromagnetic phase is registered at a stage of a doll (12 day from the moment of egg lying).

In conditions of the raised receipt of iron the mineralization of a ferromagnetic material begins on larval stages (8 - 9 day).

- For the first time, hysteresis magnetic properties of a separate bee (coercive force, a magnetic susceptibility, the magnetic moment) and their dependence on an external field are measured by method SKVID-magnetometry. Coercive force in norm makes 88,5±11,5 Э, and the magnetic moment of saturation (2,1±1,9) *10-5 е.м.е.

Identification of a magnetic material by comparison with properties magnetite with various domain structure is lead. The magnetic material of bees is identified as magnetite in a multidomain condition. Presence of a small amount magnetite (8,3 - 15,5 %) in a superparamagnetic condition Is supposed.

The quantity of a ferromagnetic phase in norm varies within the limits of 130 - 340 нг (on the average - 240 ng).

In conditions of artificial magnetic fields quantity and properties of a magnetic phase of bees vary. The long maintenance of bees in conditions hypogeomagnetic fields leads to decrease in quantity of a magnetic material and reduction coercive forces and remanence forces a ferromagnetic phase. In a hypergeomagnetic floor the opposite effect is observed: the quantity of a ferromagnetic material, and also value coercive forces and remanence forces increase.

In conditions of superfluous receipt of iron the quantity of a ferromagnetic phase essentially decreases (!).