3. Life Sciences.

Selected results obtained until now during the Slovak Space Mission to Station MIR are listed in part 1.1. Below are listed another results and activities in the slovak institutes working in Life Sciences. At the ***Institute of Animal Biochemistry and Genetics Academy of Sciences in Ivanka pri Dunaji*** model experiment with insemination of Japanese quail during hypodynamy has shown, that the efficiency of insemination depended on its frequency. In comparison with natural mating the efficiency was by 62.8% lower after 2 successive inseminations and by 41.7% after 3 successive inseminations performed during 22 days lasting hypodynamy experiment. The volume of ejaculate, sperm concentration and testosterone levels in males decreased after 15 days lasting hypodynamy.

The joint experiment with American scientists was accomplished aboard the MIR orbital station in 1996 using an innovated module of the INCUBATOR-2 device. In this experiment at the days 14 and 16 of incubation 9 embryos were identified out of 20 fixated eggs.

In experiments realized in earth conditions content of Ca in selected bones, concentration of estradiol in plasma and production traits of laying Japanese quail hens during long-lasting (84 days) hypodynamy were studied. It was found that hypodynamy affected negatively mainly body weight, egg production and egg weight of experimental group.

Ca content in skull and pelvis bones has not changed as a consequence of long-term hypodynamy and corresponded to the levels observed in control group. Increased levels of Ca were found in the ribs and hind limb bones of the experimental group submitted to hypodynamy. Concentration of estradiol was after 28 days of hypodynamy increased. However, estradiol levels 56 and 84 days after the onset of hypodynamy did not differ significantly from the control group. This return to control levels of estradiol could be a sign of adaptation to persisting effect of stressor.

As a part of the study of the possibilities of biogenic compounds recycling within a closed ecosystem it was found that the addition of quail excrements, cultivated and non-cultivated by the housefly larvae, into the feeding mixtures contaning animal proteins did not affected negatively the productivity of Japanese quail. Recycling of excrements (cultivated or non-cultivated) could substitute about 8-10 % of the grains in the feeding mixtures.

The influence of long-term hypodynamy on structure and content of mineral substances in the femur and tibiotarsus of Japanese quail was investigated. It was observed that long lasting (84 days) hypodynamy has no effect on mass, length and thickness of femur and tibiotarsus.

However, the firmness of femur was lower in quails exposed to hypodynamy as compared to control grups. The firmness of tibiotarsus was not affected by hypodynamy.

The changes of the metabolism of calcium and phosphorus in Japanese quail exposed to hypodynamy were studied. It was observed that there is gradual decrease of calcium content in dung during the hypodynamy, the excretion of phosphorus was elevated. This is probably related to use of calcium for eggshell formation (1-20).

The effects of the microgravity on the early post-embryonic development in Japanese quail were studied. A bird, Japanese quail, is proposed as an element of the closed ecological and alimentary system and it is very important as a source of food for human subjects during space flight of long duration period. A question arising from the series of previous experiments was how to provide conditions for the survival and normal development of quail during the first days of the postembryonic development. It was decided to solve this problem by using artificial gravity produced by special centrifuge on board of station MIR. Resolving this problem represents crucial step in managing reproductive cycle of Japanese quail and producing the cosmic population of this bird in space. To reach the above mentioned aim the a special centrifuge, transport incubator, module controlling the operation of the board incubator 1M aboard the orbital station MIR, transport device for return of the hatched quails, device for the bio-material fixation for morphological examination, container for the feed, were designated and manufactured (21). Experiment aboard the station MIR lasted 7 days and its accomplishment was of great importance for the studies of ontogenic development of birds under microgravity conditions. First of all the feasibility of hatching the birds in space from eggs transported from the Earth and underwent two thirds of embryonic development on the Earth, has been approved. Investigation of the process of incubation of the quail eggs under the microgravity conditions and the hatching clearly showed that quail chicks were hatching at the normal period of development. The hatchability was very high and for the first time the quail chicks in the early days after hatching were subjected to diverse conditions-microgravity and artificial gravity. A lower activity of alkalic phosphatase was observed in intestine of quail, the morphological structure of lung, bone, liver and bone marrow was not changed. A delayed development of sceletal muscle and morphological changes in adrenals were observed in quail exposed to microgravity (22-28).

An investigation of the effects of asymmetric activity of sensoric imputes (vestibular or proprioceptive) and an involvement of this activity in the development of kinetosis and orientation illusions (project Senso-asymetria proposed by ***Institute of Normal and Pathological Physiology, SAS***) during space flight and readaptation period after space flight.

The results of observations performed before, during and after space flight in Slovak astronaut showed a successful process of adaptation of vestibular system to microgravity. The stimulation of vestibular system by movements of head did not produced orientation illusions during the space flight. No important vegetative signs of kinetosis were found, but a decrease of the rate of head movement was noted. The disturbances of postural regulation were observed by using stabilometric measurement of posture, galvanostabilometry and after vibrator stimulation of leg muscles on the first day of landing. However, on the fifth day after the space flight these disturbances disappeared. New original results were observed in the readaptation of vestibulo-postural part of regulation of balance function by using a galvanic stimulation of vestibular apparatus. These results are important contribution to the studies of ethiology of kinetosis (29-31).

The functional capacity of neuroendocrine system (projects proposed by ***Institute of Experimental Endocrinology, SAS***) to respond to various stress stimuli (see also chapter 1, project ENDOTEST) during space flight was studied by the exposure of cosmonaut to physical stress (workload), to metabolic stressor (insulin induced hypoglycemia and glucose load) and to psychic stressor (mental arithmetic test). Exposure to work load during space flight produced a higher increase of heart rate compared to changes before the flight. Changes in blood pressure were, however, similar to responses on workload before or after flight. Preflight workload produced a huge increase in plasma norepinephrine levels and moderate increase of plasma epinephrine levels. During space flight exaggerate response of both catecholamine plasma levels to workload were demonstrated. Significantly reduced plasma epinephrine response to insulin induced hypoglycemia was found during space flight compared to preflight changes. Plasma norepinephrine responses to insulin administration were not different compared to preflight levels. The higher increases of plasma growth hormone and prolactin levels were noted after workload during space flight as compared to preflight responses. However, a diminution of plasma prolactin and growth hormone responses to insulin induced hypoglycemia was observed during space flight. The results of oral glucose tolerance test showed that utilization of glucose was slightly delayed during space flight as compared to preflight values. A slight increase of plasma insulin and C-peptide levels in plasma was observed in glucose tolerance tests during the space flight and in postflight period. Plasma epinephrine levels were slightly reduced and plasma norepinephrine levels were not changed during glucose tolerance tests both in preflight and in-flight tests. The responses of plasma catecholamine levels to mental arithmetic test were relatively small and

were not affected by the space flight. The results demonstrate different responses of neuroendocrine system to some stressors during space flight and in the conditions of Earth gravity (32-34).

Simultaneously with space mission two-control ground projects Training and Metabolism were performed on human volunteers. The aim of the project Training was investigation of the effects of endurance training of astronauts in preflight period on the neuroendocrine and cardiovascular responses to various stress stimuli. The aim of the project Metabolism was to study the metabolic consequences of decrease physical activity of astronauts during space flight and in subjects during simulated microgravity on Earth.

Functional tests similar to those used in the project ENDOTEST were performed on the group of army aircraft pilots: physical exercise (80 % $VO_{2\ MAX}$), mental arithmetic, glucose tolerance test, insulin hypoglycemia and for evaluation of orthostatic tolerance Shellong test was added. Investigation was performed before and immediately after endurance training (1 hour of running at 75-80 % $VO_{2\ MAX}$, four times a week, lasting 6 weeks). The same functional tests were applied (project Metabolism) before and after 5 days of head-down strict bedrest (-6° tilt).

The results obtained in these two project should indicate the optimal pre-flight training of astronauts and some consequences of limited physical activity during space flight from point of view of neuroendocrine regulation of body function. The simulation of microgravity conditions by bed rest, even for a short period of 5 days, resulted in disturbance of glucose metabolism with increase of insulin secretion, in changes of the response of cardiovascular system to up right position with increase of the activity of renin angiotensin system and plasma aldosterone levels. Higher increase of prolactin plasma levels and diminished secretion of growth hormone as compared to control subjects followed physical exercise. The clinical investigations are still in progress. Results of previous observations from space physiology are in papers 35-38.

Terrestrial simulation experiments were performed by ***Institute of Animal Physiology, UPJŠ***, ***Košice*** and demonstrated that fractionated irradiation, twice weekly 2.4 Gy of gamma rays, total dose 4.4, 9.6 or 14.4 Gy of gamma rays, decreased at some interval the pineal activity of serotonin N-acetyltransferase, decreased the concentration of melatonin in the pineal as in serum. The activity of pineal monoaninooxidase activity increased in the highest dose, and declared the possibility of preferential deamination of pineal serotonin in these animals (39). Two-phase response of pineal melatonin was assayed in 9.6 Gy of gamma ray-irradiated male rats. Early (60 min.) after the exposure melatonin decreased, later increased, and with

temporary increased serotonin N-acetyltransferase activity in the pineal (40). Metabolic and hormonal changes in irradiated rats, focused on the effect of continuous irradiation with gamma rays, were summarized (41).

In chronobiology experiments it was observe that circadian oscillations of serum thyroid hormones in male rats were more pronounced in individual seasons comparing to the effects of selected photoperiods, when the experiments was realized in a single season (43). A distinct circadian rhythm in pineal dopamine, norepinephrine and epinephrine was found in the pineal of male Wistar:Han rats. The highest values were obtained in the first part of darkness, generally higher values were obtained during the darkness (42).

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