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BEHAVIOUR OF JAPANESE QUAIL IN MICROGRAVITY ON THE "MIR" ORBITAL STATION

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Abstract

Behaviour of newly hatched and adult Japanese quail was analyzed using videorecordings from two experiments conducted aboard the MIR orbital station.

Weightlessness caused problems in motor behaviour of unrestricted quail. Especially in newly hatched quail (their entire embryogenesis proceeded under microgravity conditions) bodily rotations and bouncing against the walls of the rearing device "Nest" did not allow them to feed. The problems with movement and spontaneous feeding were not so serious in adult, unrestricted birds.

Although some signs of adaptation to microgravity could be seen, further data are necessary for estimating possibilities of behavioural adaptation to microgravity.

Adaptation, microgravity, behaviour, feeding

Introduction

The aim of cosmic biology is to create conditions necessary for the long-term stay of man on cosmic orbital complexes and planetary stations. Such conditions should be provided by the autonomous closed ecosystem – a simplified model of the terrestrial biocenosis. As an experimental model of the higher heterotrophic link of this ecosystem, the Japanese quail was chosen (Boďa 1980). This paper presents recent knowledge on the behaviour of newly hatched and adult quail under conditions of weightlessness. Videorecordings made as part of the experiments aboard the MIR orbital station do not meet the criteria of systematic behavioural observation required for qualitative and quantitative behavioural analysis on Earth. Nevertheless, the data are highly interesting and original and were therefore analysed and summarized.

Materials and Methods

Videorecordings of behaviour were taken from two independent experiments.

The aim of the first experiment, Incubator – 2, (Meleshko et al. 1991; Boďa et al. 1991), was to answer the question, whether or not the whole cycle of embryogenesis, including the hatching of viable quail chicks, is possible under microgravity conditions. The experiment took place aboard the MIR orbital station from 4 March to 24 March, 1990. 21 of 43 incubated eggs were fertile, and 8 embryos of the 21 fertile eggs reached the final stage of development. Six of these emerged from the shell and were placed into the rearing device "Nest". Two videorecordings documented their behaviour.

The aim of the second experiment was to study the reaction of adult Japanese quail to microgravity (Sabo et al. 1992). Three females and 1 male, each aged 65 days, were transported on 1 August 1990 in a special container by a transport spaceship to the orbital station MIR. During the transport the birds were fixed in "jackets". Such "jackets" are modifications of those used in the selection of hypodynamy resistant quail (Juráni et al. 1984; Juráni et al. 1988). From this selection the quail used in the aforementioned experiments were chosen. Aboard the MIR station the birds were transferred to the "Nest" device. In the "Nest" birds were again fixed in "jackets" and placed in front of feeders. After 7 days aboard the MIR station, all birds returned to Earth on August 9, where a study of their behaviour continued. For this experiment one videorecording was used.

Results and Discussion

Each quail hatched in our first experiment under microgravity conditions possesed the characteristics of a normal development and responded normally to visual and auditory stimuli. The motor activity of newly hatched chicks was uncoordinated. Their main problems were rotation around their own axis, and subsequent to their placement in the "Nest", bouncing against the walls. Nevertheless, from videorecordings and cosmonaut commentary on such records it seems that large interindividual differences occurred. Bodily rotation was not observed with the same intensity in all chicks.

We can only speculate whether motor coordination will improve with time, and whether both rotation and rotational speed will be reduced as a consequence of the adaptation to microgravity. Although we had hoped to answer this question, it was not possible. Due to problems of movement hatched quail were not able to reach the feeder where the paste food (mixture of 25 % food and 75 % water) was provided. Feeding behaviour (according to videotape and cosmonaut commentary) was observed only in quail chicks held in the hand of a cosmonaut. Here such behaviour occurred immediately after hatching. Quail chicks selected the bigger particles. After a sequence of 2–4 pecks a short break was observed, after which pecking resumed. Following 4–5 cycles of pecking the food intake ceased. Because this feeding pattern was too time consuming for cosmonauts and interfered with their schedule, it was decided to sacrifice the birds for further morphological studies. Therefore data on behavioural changes are not available.

Consequently, in preparing the second experiment with adult quail much greater attention was paid to restraint. Here mechanical fixation was not a problem, however, due to experience gained in the restraint of adult quail from the aforementioned selection experiments (Juráni et al. 1984; Juráni et al. 1988). On videotape it seems that quail in "jackets" had no difficulties with feeding and that their behaviour was quite normal, taking into consideration the restriction of movement in the modified "jackets". The feeding behaviour of an unrestrained animal was also videotaped (including the approach to the feeder, although it cannot be said with certainty whether it occurred by activity or by chance), as well as its movement inside and outside the "Nest". The movement of adult quail aboard the orbital station did not appear as uncoordinated as that of the newly hatched birds, although problems with the direction of movement were apparent. However, quail spent most of their time in "jackets" and their unrestrained behaviour in the "Nest" needs a more detailed study. After the return to Earth unnatural postures were observed in the quail. The head extended toward the chest as the trunk arched forward (Fig. 1). When moving they could hardly maintain equilibrium, falling forward or drifting to the side. Nevertheless, their reaction to food was fairly normal.

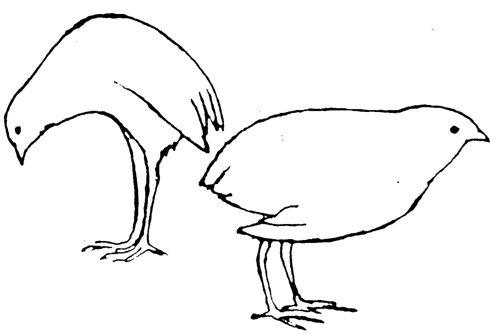

Fig. 1. Unnatural posture of quail after the return to Earth

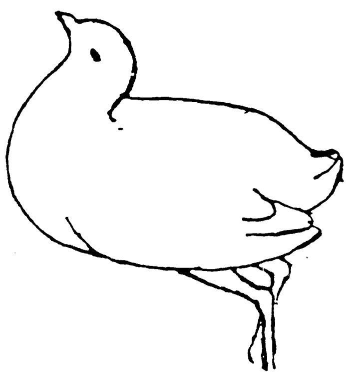

Fig. 2. Extensor reaction of quail under conditions of microgravity

What is responsible for these behaviour differences between newly hatched and adult quail? Are ontogeny, development, individual history, and experience the only sources of these differences? Quite importantly animals in both experiments differed in one important respect. Unlike those of the second experiment, the entire embryogenesis of quail from the first experiment proceeded under microgravity conditions. In domestic chicks incubated (partially) aboard the NASA space shuttle Discovery, persistent vestibular threshold shifts in vestibular responses were indicated (Jones et al 1991). Such changes might also contribute to the differences noted in quail behaviour from the first and second experiment.

Which underlying physiological mechanisms of observed behaviour can be assumed? The reaction of animals to weightlessness is probably identical to that of an organism to free fall. In mammals the motor activity increases. Except in the guinea pig and rabbit, extensor reactions of the extremities and trunk, rotational movements of the tail and an activation of the grasping reflex are observed. After the ceasing of the motor reaction the extensor reaction becomes more pronounced. At a certain stage of adaptation this reaction gradually disappears and the animals are "suspended" in mid-air, with extremities retracted to the abdomen.

Under short-term weightlessnes wing movement, in the form of continual attempts to soar, was observed in birds. They would soar "up" to the ceiling, and then "down" to the ground, and then again to the ceiling, etc. After the third short-term weightlessness regimen this reaction ceased. The birds were "suspended" in the air in the typical position – with wings stretched behind the back and erected tail feathers. "Suspension" of the birds with folded wings and tail occurred between regimens 8–20. It may be presumed that bird adaptation to weightlessness might be more rapid than that of mammals, due to their natural adaptation to the increasing and decreasing gravitational forces which are quickly changing during the flight (Katajev–Smyk 1974).

Weightlessness seems to induce defensive reactions. The information is received from gravireceptors, especially vestibular, and from a number of interoreceptors. They signal a lack of support, a falling motion, and continual change in position. Visual information simultaneously signals the stability of environment. Thus each signal opposes the other.

It may be assumed that signals from gravireceptors indicating the fall evoke changes in the motor behaviour – motor stimulation and high tension of extensors. Visual information indicating a stability of environment will gradually decrease gravireceptor impulses. Some behavioural changes – extensors reaction (Fig. 2) and "suspension" – are in favour of the adaptation of the Japanese quail to weightlessness.

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