Adaptability of Japanese Quail Chicks to Conditions of Simulated Weightlessness

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Abstract

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The objective of this study was to evaluate the adaptability of young Japanese quail chicks to the simulated weightlessness, represented by hypodynamy. Unsexed hatchlings were subjected to hypodynamy on either the first, second or third day of age and reared under these conditions to 21 days of age. During this period, the control quail chicks were housed in a floor box.

The effect of hypodynamy on adaptability of chicks was significant ($P < 0.001$). Approximately 75 % of all chicks exposed to hypodynamy were not able to adapt in three experimental groups, although significant differences in adaptability were not found between these groups. Those birds were considered as non-adapted (eliminated from experiment) that manifested hyperactivity, escape attempts, turning 180° in the sling, soaking in the water from the drinker, as well as the total apathy, at least three times per day. This experiment confirmed that some quail chicks are capable of adapting to conditions simulating weightlessness to 21 days of age and that the first 2-weeks after hatching may be a critical period of quail sensitivity to hypodynamy. This finding raises a key issue relevant to rearing quails in simulated weightlessness until the age of sexual maturity.

Quail, hypodynamy, adaptability

The long-term stay of man in space environment will depend upon establishing an autonomous closed ecosystem (Meleshko and Shepelev 1996). Japanese quail could be used as a higher heterotrophic link in this system, especially as a protein food source (Boďa 1993). For nearly three decades, Slovak, Russian and American scientists have co-operated in the realization of this objective. The results have shown that embryogenesis of Japanese quail can be performed in the conditions of weightlessness (microgravity) without serious difficulties (Guryeva et al. 1993; Dadasheva et al. 2001). In experiments on board MIR space station, Japanese quail embryos have successfully completed embryogenesis. The hatched quail chicks had all the external characteristics of a normal development, they responded to visual and auditory stimuli, and manifested motor and vocal activity (Boďa et al. 1992; Sabo et al. 2001). Moreover, the embryogenesis of domesticated chicken on the Space Shuttle STS-29 was investigated. According to this study, the 9-day flight embryos (incubated in orbit until day 14) continued their incubation to hatch at 21-day under the condition of normal gravity, revealed no gross abnormalities, and developed normally to adults; 2-day embryos aboard the same flight all died during the 5-day mission (Hullinger 1993).

How microgravity may influence further development of quail and domestic chicken during the different ontogenetic phases is unknown. However, the ground-based animal models of simulated microgravity (hypodynamy) may provide a partial answer to some of these questions. The first studies to examine the effect of hypodynamy were realized on the adult Japanese quails (Juráni et al. 1983). In another experiment, lasting 84 days, it has been observed that hypodynamy exerts a negative effect on live body mass, feed

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consumption and egg laying (Sabo et al. 1998). However, there are minimal data on adaptability of Japanese quail chicks to hypodynamy (Škrobánek et al. 2001).

The aim of the present study was to establish feasibility of rearing Japanese quail chicks in simulated weightlessness (hypodynamy) from hatching to 21 days of age. The general hypothesis of this study is that hypodynamy will alter the ability of Japanese quails to adapt in these specific hypodynamy conditions. Such information may also play an important role in our understanding of how the microgravity environment may influence development of quail chicks reared on board the International Space Station.

Materials and Methods

Sixty-four newly hatched, unsexed chicks of the hypodynamic line of Japanese quail (Laying Line 01 Ivanka pri Dunaji) were randomly divided into four groups of 16 birds each, all of similar body weight. On the day of hatching, each group was placed in rearing box (1.2 m × 0.6 m × 0.3 m) that was electrically heated by infrared lamps and maintained in a windowless room with controlled ventilation. Temperature in the boxes was adjusted from about 35 °C during week 1 to about 25 °C during week 3. A commercial starter mash HYD-13 and water were available *ad libitum.* The diet was granular and contained 260 g·kg^{-1} protein and 11.5 MJ metabolisable energy per 1 kg. The lighting regime provided continuous light. The birds of control group were kept on the floor until they reached 21 days of age. Birds of three experimental groups were reared in simulated weightlessness (hypodynamy). After hatching, the quail of first, second and third groups were subjected to hypodynamy after 6, 30 and 54 hours (day 1, 2 and 3), respectively, of their removal from the hatchery. Before the treatment, quail were housed at standard rearing conditions on the floor. Thereafter, they were placed into individual slings suspended by a flexible metal devise such that legs could not touch the floor. However, the chicks were able to move about freely by moving their wings. The size of the slings was enlarged at 7 days and again at 14 days of age (from 4 cm × 3 cm to 5 cm × 4 cm and 6 cm × 5 cm) to accommodate the growth of the quail. This exchange of smaller sling size for the larger one took approximately 15 seconds. To minimize the stress of handling, the quail chicks were not weighed during the experiment. Adaptability was the only criterion recorded daily throughout the experiment. Those of quails were considered as non-adapted (eliminated from experiment) that manifested the hyperactivity (intensive wings and legs movements), escape attempts, turning 180° in the sling, soaking in water from the drinker, as well as the total apathy, at least three times by daylight. The quail behaviour was monitored daily at five about two-hour intervals. Values were expressed as the number of adapted versus non-adapted animals or as the percent adaptability. Statistical significance was evaluated using Student's t-test.

Results and Discussion

The first chicks in all three experimental groups exposed to hypodynamy were excluded from the experiment due to problems with adaptation to the slings (hyperactivity, escape attempts, intensive wing and leg movements, turning 180° in the sling, soaking in water from the drinker) as early as day 2 or 3. During the following seven days, 7, 6 and 4 non-adaptive quail chicks were excluded from groups 1, 2 and 3, respectively. By day 14 days of exposure to hypodynamy 5, 4 and 6 chicks remained in groups 1, 2 and 3, respectively. By day 21 of hypodynamy this number further decreased to 4, 3 and 5 chicks (Table 1).

Our observations are in a partial agreement to our earlier findings that hypodynamy exposure causes a decrease in the survival of quail hatchlings (Škrobánek et al. 2001). Approximately 75 % of all experimental quail chicks were excluded from experiment due not adapting in the three experimental groups during 21 days of hypodynamy (Fig. 1). Although the majority of the adapted birds were found in the third experimental group exposed to hypodynamy on 3 days of age (54 hours), the differences between the groups were not significant. In the same way, the most quails were excluded within the first few days of hypodynamy and after the change of slings at age of 7 days. Taken together with our earlier study, our findings support the view that younger quails are more vulnerable to deleterious effects of hypodynamy than 14-day-old birds.

Hypodynamy represents a good model of simulating microgravity (Juráni et al. 1989). Changes observed after the exposure to weightlessness and hypodynamy are very similar (Dadasheva and Guryeva 1993; Kočišová 1994). Both hypodynamy and

Table 1
Adaptability of Japanese quail chicks after exposure to hypodynamy after 6, 30 or 54 hours, respectively, of their removing from hatchery (adapted/excluded)

Age (days)	**Hypodynamy** Treatment Group **1H**(6 h)	**2H**(30 h)	**3H**(54 h)	**Control**
1	16 / 0	-	-	16 / 0
2	16 / 0	16 / 0	-	16 / 0
3	14 / 2	14 / 2	16 / 0	16 / 0
4	13 / 3	12 / 4	16 / 0	16 / 0
5	10 / 6	10 / 6	15 / 1	16 / 0
6	9 / 7	10 / 6	12 / 4	16 / 0
7	**9 / 7** [a]	**10 / 6** [a]	**12 / 4** [a]	**16 / 0** [b]
8	8 / 8	8 / 8	12 / 4	16 / 0
9	7 / 9	7 / 9	11 / 5	16 / 0
10	6 / 10	7 / 9	9 / 7	16 / 0
11	6 / 10	7 / 9	8 / 8	16 / 0
12	6 / 10	4 / 12	7 / 9	16 / 0
13	6 / 10	4 / 12	6 / 10	16 / 0
14	**5 / 11** [c]	**4 / 12** [c]	**6 / 10** [c]	**16 / 0** [d]
15	4 / 12	3 / 13	6 / 10	16 / 0
16	4 / 12	3 / 13	5 / 11	16 / 0
17	4 / 12	3 / 13	5 / 11	16 / 0
18	4 / 12	3 / 13	5 / 11	16 / 0
19	4 / 12	3 / 13	5 / 11	16 / 0
20	4 / 12	3 / 13	5 / 11	16 / 0
21	**4 / 12** [c]	**3 / 13** [c]	**5 / 11** [c]	**16 / 0** [d]

[a, b] $P < 0.05$
[c, d] $P < 0.001$

weightlessness induce non-specific stress associated with acute adaptation (Juráni et al. 1991). Cessation of egg-laying, decrease in food intake and changes in behaviour are observed in birds (Boďa et al. 1992; Sabo et al. 1998). In the present study, hypodynamy reduced food intake and caused hyperactive behaviour of quail chicks (escape attempts, scattering food from the feeder, intensive wing and leg movements). It remains unknown whether the stress of sling restraint in 1 *g* conditions is masking any simulated weightlessness variable. However, several quail chicks were able to adapt to the procedure of hypodynamy induction. Non-adapted quails were excluded from the experiment. Hence, we propose that selection and breeding of animals could be used to increase their adaptability to simulated weightlessness. Genetic selection has already been used from improving adaptation of adult quails to hypodynamy. The selection criterion was egg-laying during hypodynamy (Juráni et al. 1996). Our data suggest that genetic selection with another criterion, adaptability in early post-hatch period, could be successful.

Our results confirm that selected Japanese quail chicks may be reared in the conditions of simulated weightlessness (hypodynamy). It was shown that some quails are capable of adaptation to hypodynamy. Additional studies are needed to understand how hypodynamy affects not only ability to adapt to the procedure as such, but also growth and development of quail chicks from hatching to sexual maturity.

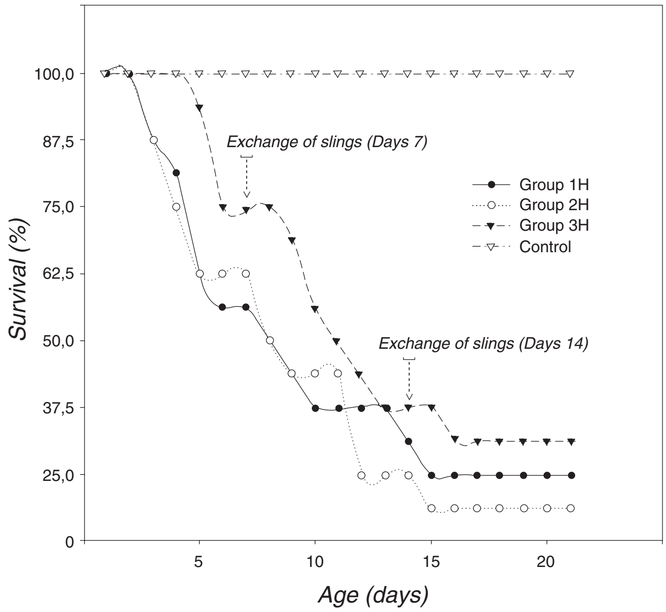

Fig. 1.
Effect of hypodynamy on survival of Japanese quail chicks to 21 days of age

Adaptačná schopnosť kurčiat prepelice japonskej v podmienkach simulovaného beztiažového stavu

Cieľom našej práce bolo skúmať pôsobenie simulovaného beztiažového stavu na adaptačnú schopnosť kurčiat prepelice japonskej. Ako metóda bol použitý model hypodynamie. Kurčatá bez určenia pohlavia boli vystavené vplyvu hypodynamie na prvý, druhý alebo tretí deň veku, a za týchto podmienok boli odchovávané do veku 21 dní. Počas tejto doby boli prepelice kontrolnej skupiny odchovávané v boxe.

Vplyv hypodynamie na adaptačnú schopnosť kurčiat bol významný ($P < 0{,}001$). Približne 75 % kurčiat troch experimentálnych skupín vystavených hypodynamii nebolo schopných adaptovať sa, pričom rozdiely medzi týmito skupinami neboli významné. Ako neadaptované boli považované tie prepelice (vyradené z pokusu), ktoré opakovane (minimálne 3-krát) prejavili hyperaktivitu, pokúsili sa o útek, otočili sa v hypodynamickom závese o 180°, zmáčali sa v napájačke s vodou alebo vykazovali celkovú apatiu. Tento experiment však potvrdil, že niektoré prepeličie kurčatá sú schopné prispôsobiť sa podmienkam simulovanej mikrogravitácie do veku 21 dní, a že prvé dva týždne po vyliahnutí sú kritickým obdobím ich citlivosti voči hypodynamii. Tento poznatok nastoľuje kľúčový problém, týkajúci sa odchovu prepelíc v podmienkach simulovaného beztiažového stavu až do veku pohlavnej dospelosti.

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