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Behaviour of Japanese quail (*Coturnix japonica*) kept in semi-natural aviaries

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Abstract

In caged Japanese quail (*Coturnix japonica*), there are several welfare problems such as head injuries caused by aggressive pecking and head-banging as a consequence of escape responses. The present study is aimed at improving the knowledge of the behaviour of this farm animal species for the design of adequate housing systems. From May to October, eight groups of eight or nine quails of a domestic strain were housed in aviaries (19.1 m^2) containing natural soil and vegetation. There were two groups with hens only and six groups of varied sex ratio. A time budget analysis showed that the quails spent 35% of the observation time on passive behaviour, 24% on locomotory behaviour, 8% on exploratory/foraging behaviour, 14% on comfort behaviour and 4% on ingestive behaviour. The percentage of time the quails stayed in cover (average 48%) was significantly higher than the proportion of the floor area that was covered with plants and artificial shelters. On the other hand, the time spent on elevated structures (average 0.5%) was significantly lower than expected. Based on data of spatial proximity 'close relationships' of a given hen with a cock were identified. Most of these relationships broke up after the end of the reproductive period. Aggressive behaviour was rare in groups without cocks. In heterosexual groups, 67% of the aggressive interactions were observed between cocks. The percentage of eggs found in cover (average 91%) was significantly higher than expected. The hens also laid significantly more eggs than expected in the corners and within a zone of 0.1 m along the border of the aviaries. In the discussion, recommendations are made for the design of housing systems that are adapted to the behaviour of domestic quails. © 1997 Elsevier Science B.V.

Keywords: Japanese quail; Housing; Time budget; Social behaviour; Egg laying behaviour

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1. Introduction

The Japanese quail (*Coturnix japonica*) has been domesticated since at least the twelfth century AD, when it was kept as a song bird in Japan (Kovach, 1974). Around 1910 systematic selection for good laying quails was started (Yamashina, 1961). In the 1950s, the species was imported into Europe where specific lines are bred for egg and meat production (Gerken and Mills, 1993). The domestic quail shows rapid growth and attains sexual maturity at 5–6 weeks of age. Nowadays, quails of meat type strains are slaughtered at 5 weeks of age with a weight of 160–250 g (Gerken and Mills, 1993). Females enter into full lay at about 8–9 weeks of age. Layers are usually kept up to 8–10 months of age and produce about 300 eggs per year (Baumgartner, 1994) each with a weight of 7–11 g (Wakasugi, 1984). Due to its small size and short generation interval, the Japanese quail is also popular as laboratory animal (Kovach, 1974; Ratnamohan, 1985; Cooper, 1987).

Japanese quails are farmed intensively. For example, the minimum floor area prescribed per quail in Switzerland is 100 cm^2 for growers and 110 cm^2 for layers. Birds bred for meat production are often kept on the floor whereas breeding stock and layers are usually kept in battery cages (Gerken and Mills, 1993). Quails reared on the floor are kept on wood-shavings in windowless rooms and in flocks of several thousand birds per housing unit. Cages usually have a floor area of 1.0 m × 0.5 m and are 16–20 cm high (Gerken and Mills, 1993). They are arranged in batteries with 4 or 5 tiers. The floor of the cages is sloped to facilitate egg collection. A sex ratio of 1 male per 2–3 females is recommended for breeding stock groups (Cooper, 1987).

There are several welfare problems in intensive quail housing systems such as head injuries caused by aggressive pecking, wounds on the back of females due to frequent mounting, head-banging as a consequence of escape responses, feather damage, leg weakness and foot problems (reviewed by Gerken and Mills, 1993). The problems are most pronounced in caged quails which also show vacuum dustbathing and symptoms of pre-laying restlessness. With the domestic chicken alternatives to cage housing systems have been developed as a consequence of similar welfare problems in caged hens (reviewed by Appleby and Hughes, 1991).

The study presented here is part of a research project that aims at developing alternative housing systems for grower, layer and breeder groups of Japanese quail. Knowledge of the normal behaviour of a species is a prerequisite for the design of appropriate housing systems. With the Japanese quail, however, there is little information on the behaviour in a natural habitat (Taka-Tsukasa, 1967). Quantitative studies on the behaviour of quails have only been made in captivity and in most cases with caged birds (reviews by Kovach, 1974, 1975; Gerken and Mills, 1993). We therefore started our research project with a study on the behaviour of quails housed in small groups of varied sex ratio in semi-natural aviaries. In this paper we present data on (1) time budgets, use of cover and elevated structures, (2) social behaviour and (3) preferences for egg laying places in these extensively housed quails.

2. Methods

2.1. Animals and housing conditions

Eight groups of eight or nine quails each were housed in semi-natural outdoor aviaries from May to October 1994. Sex ratio was varied between groups. There were two groups with four hens and four cocks, two groups with six hens and three cocks, two groups with six hens and two cocks and two groups with eight hens and no cock. The birds were of a strain that is used for both meat and egg production. The quails were introduced into the aviaries at the age of 33 days on May 2nd. Up to this date they had been reared in battery cages on a commercial quail farm. During the study all quails were individually marked with coloured leg rings.

Eight aviaries with a floor area of 4.9 m × 3.9 m each were built side by side. They were either 2 m ($n = 6$) or 4 m ($n = 2$) high. The sides and the tops were made of wire mesh. Quails of neighbouring groups were separated by visual barriers (40 cm high) fixed along the sides. The floor consisted mainly (65–80%) of natural soil. In the centre of each aviary an area of 3.4–6 m^2 was covered with a mixture of wood chips and humus. All aviaries contained some willows and grass as well as various herbs that grew on the natural soil in the course of the seasons.

The animals had ad libitum access to fresh water and a commercial quail laying-hen food (crumbs). The food dispenser was situated under a wooden shelter. The quails could take cover both in the vegetation and under various artificial structures, i.e., shelters made of a wooden board or a rush-mat and stacks of willow or spruce twigs. The number, size and type of these structures varied between the aviaries.

2.2. Data collection and analysis

Focal animal sampling (Altmann, 1974) was used to quantify the time budget of the quails in July and August. Each quail ($n = 66$) was observed for four periods of 10 min in four time blocks distributed over the day (between 07:00 and 20:00 h Swiss summer time). Data assigned to different time blocks were collected on different days. Within a time block all members of a group were chosen as focal animals in a random sequence. For a given group data collection was completed within a period of 4 to 7 days. Total observation time per group was 320 min in aviaries with eight quails and 360 min in aviaries with nine quails. Observations were made from outside the aviary (distance to the wire mesh about 1 m) without the use of a hide. 2 to 3 days before the start of the behavioural observations the quails were marked with coloured wing bands in addition to the leg rings to facilitate individual recognition.

During a focal animal protocol, all transitions between 11 defined activities (standing, sitting, resting, lying on side, walking/running, flying, pecking/scratching, preening, dustbathing, feeding, drinking) were recorded using the programme 'The Observer 3.0' (Noldus Information Technology, Wageningen, the Netherlands). In addition, it was recorded whether the focal animal was in cover (under plants or artificial shelters) and whether it stayed on the floor or on elevated structures (artificial shelters and willow branches that could be used by the quails). In the analysis, the amount of time the quails spent in cover and on elevated structures was compared to the percentage of the floor area that was covered with plants or artificial shelters and elevated structures, respec-

tively. These percentages were estimated per square metre of the floor after completion of the time budget records in a given aviary. Whenever a quail was pecking/scratching during a focal animal protocol it was recorded which substrate the behaviour was directed at. The quality of the substrate was also noted for all dustbathing events. As dustbathing is a relatively rare but easily detectable behaviour, the occurrence of dustbathing was recorded not only for the focal animal but also for all other group members in order to increase the sample size with regard to substrate preferences. In addition to the focal animal sampling, continuous observations were made in all eight groups on 12 evenings (one group per evening) to count the number of quails that used a perch to rest at night.

Focal animal sampling was also used in July and August to quantify the social behaviour of the quails in each group. These data were collected by the same observer but not at the same time as the time budget records. As with the latter, each quail ($n = 66$) was observed for four periods of 10 min in four time blocks, data assigned to different time blocks were collected on different days, and all members of a group were chosen as focal animals in a random sequence within a time block. During a focal animal protocol, all occurrences of approaching (coming nearer than 0.2 m to another quail), being together (staying less than 0.2 m distant from another quail, both quails not in locomotion), copulating (the cock mounts the hen for more than 2 s), pecking and chasing were recorded using the programme 'The Observer 3.0'. Being together was repeatedly recorded as an event every 20 s. The identity of the partner was noted for all social interactions. With approaching, copulating, pecking and chasing it was differentiated whether the focal animal was the actor or the receiver of the interaction. Since copulations were rare events, they were also recorded in the time budget protocols described above, and the two data sets were combined in the analysis.

At the end of each focal animal protocol (both time budget records and observations on social behaviour), all members of a group were again chosen in a random sequence, and the next three neighbours of each quail were recorded. Only neighbours within a distance of 0.6 m (approximately 3 times the length of a quail) were considered. A quail could therefore have between zero and three neighbours in a given record. These data on spatial proximity were used to quantify the number of 'close relationships' established in each group. In the analysis, a 'close relationship' was defined as a dyad in which the cock had been a neighbour in more than 40% of all records of the hen and vice versa. In three aviaries, data collection on social behaviour was repeated later in the season (September). Since we could no longer find any 'close relationships' in these three aviaries, data collection was stopped.

The hens laid eggs between May 19th and September 20th. Eggs were not collected every day, but the place where the egg was found were recorded for a sample of 630 eggs laid on 59 days. Four categories were distinguished with regard to the distance (D) between the egg and the aviary's border ($D \leq 0.1$ m, 0.1 m $< D \leq 0.3$ m, 0.3 m $< D \leq$ 0.5 m, $D > 0.5$ m). Eggs found in a corner (defined as a square of 0.3×0.3 m^2) of an aviary were assigned to a special category. In the analysis, the spatial distribution of the eggs was compared to the percentages of the floor area that were covered by the defined categories. In addition to these categories, it was noted whether the egg was in cover or not.

For eggs laid between August 16th and September 20th ($n = 274$), the proportion of eggs found in cover was compared to the percentage of the aviary's floor that was covered with plants or artificial shelters (as quantified for the time budget analysis). Eggs laid before the focal animal observations were excluded from this analysis, as the amount of cover provided by the vegetation was gradually increasing until mid summer. This analysis was done with seven aviaries only, because in one aviary (No. 4) there was a hen raising chicks that had hatched on July 6th. In order to avoid disturbance, the other quails were removed from this aviary.

The markings on quail eggs vary, each hen producing a unique pattern (Lucotte, 1978). With eggs that had distinct patterns, it was thus possible to see whether each hen chose its own egg laying place or not.

Non-parametric statistics were used (Wilcoxon matched-pairs signed ranks test). Statistical tests are two-tailed with an alpha level of 0.05. All analyses were performed using Systat (Wilkinson, 1992). Tables published in Siegel and Castellan (1988) were used to assess statistical significance.

3. Results

3.1. Time budget

Table 1 shows the time budget of the quails in the semi-natural aviaries. On average ($n = 8$ aviaries) the quails spent 35% of the observation time on passive behaviour (standing, sitting, resting, lying on side), 24% on locomotory behaviour (walking, running, flying), 8% on exploratory/foraging behaviour (pecking and scratching away from the feeder), 14% on comfort behaviour (preening, dustbathing) and 4% on ingestive behaviour (feeding, drinking). In 15% of the total observation time, the focal animal was in dense vegetation or behind a shelter and therefore not visible.

Table 1
Percentages (mean and range) of total observation time the quails spent on defined activities ($n = 8$ aviaries)

Activity	% Time	Range
Standing	17.6	(10.2–26.0)
Sitting	6.5	(1.9–10.9)
Resting	11.0	(1.2–18.7)
Lying on side	0.1	(0.0–0.3)
Walking/running	23.7	(12.8–39.4)
Flying	0.01	(0.0–0.02)
Pecking/scratching	8.3	(4.1–15.8)
Preening	11.6	(8.7–14.4)
Dustbathing	2.2	(0.2–4.3)
Feeding	3.1	(1.4–5.8)
Drinking	0.6	(0.2–1.4)
Not visible	15.3	(1.5–36.4)

Exploratory/foraging behaviour was observed in all individuals ($n = 66$). Most of this behaviour was directed to the natural soil (63%) and the wood chips (24%) whereas plants seemed to be of minor interest (5%).

A total of 271 dustbathing events were recorded in 56 quails. This behaviour was mainly performed on natural soil (91%) and sometimes on wood chips (9%). In each aviary, there were one to three dustbathing sites which were regularly used by the quails, especially during warm afternoons.

The quails had a clear preference to stay in cover. The proportion of observation time spent in cover (average 48%, range 36–66%, $n = 8$ aviaries,) was significantly higher than the proportion of the floor area that was covered with plants and artificial shelters (average 17%, range 11–25%; Wilcoxon matched-pairs signed ranks test, $n = 8$, $T = 36$, $P < 0.01$).

Elevated structures were significantly less used than expected. On average 12% ($n = 8$ aviaries, range 7–18%) of the floor area was covered with elevated structures, but the quails spent (on average) only 0.5% (range 0–4%) of the observation time on these structures (Wilcoxon matched-pairs signed ranks test, $n = 8$, $T = 36$, $P < 0.01$). In five aviaries, no focal animal was ever seen on an elevated structure. During the continuous observations on 12 evenings none of the quails perched for rest at night.

3.2. Social behaviour

In the six aviaries with a heterosexual group composition there were nine dyads fulfilling the definition of a 'close relationship' (Table 2). Interestingly, most of these relationships broke up after the end of the reproductive period. In three aviaries (Nos. 3, 5 and 6) with a total of eight 'close relationships' during the egg laying period (July) there were no longer such relationships in the second observation period (September). Not all cocks had a 'close relationship' with a hen during the egg laying period, and none of the quails had a 'close relationship' with more than one group member, irrespective of the sex ratio in the group. Applying the definition of 'close relationship' to hen–hen dyads for the two aviaries with eight hens and no cocks we found only one out of 56 possible dyads that met this definition (data collected during the egg laying period).

Table 2
Occurrence of 'close relationships' in quail groups observed before and/or after the egg laying period

Aviary	Group composition hens/cocks	First observation period	Close relationships	Date of the last egg	Second observation period	Close relationships
1	6/2	23.8–27.8	0	18.8	–	–
8	6/2	29.8–2.9	0	5.9	–	–
3	6/3	19.7–22.7	3	19.8	19.9–22.9	0
4	6/3	5.9–9.9	1	17.8	–	–
5	4/4	11.7–17.7	4	13.9	12.9–16.9	0
6	4/4	12.7–18.7	1	9.9	12.9–15.9	0
2	8/0	2.8–5.8	1	13.9	–	–
7	8/0	8.8–11.8	0	20.9	–	–

The exclusiveness of the 'close relationships' (identified on the basis of the records of the next three neighbours) was also evident in the records of the focal animal observations. In the nine hens with a 'close relationship', the respective cock was on average involved in 72% ($n = 727$ events, range 31–94%) of the hen's 'approaching' interactions with cocks and in 78% ($n = 452$ events, range 30–100%) of the hen's 'being together' events with cocks. A total of 37 copulations were recorded in the six aviaries with heterosexual groups. The nine cocks with a 'close relationship' copulated frequently with the preferred hen (average 69%, $n = 31$ events, range 0–100%), and this was also true for the nine hens with a 'close relationship' (average 67%, $n = 29$ events, range 0–100%). Six cocks and four hens of this sample were never seen to copulate with a group member other than their preferred partner.

During the focal animal observations a total of 112 chasing and 97 pecking events were recorded. There were only 6 such events in the two hen groups compared to 203 events in the six heterosexual groups. Although cock–cock dyads accounted for only 11% ($n = 20$) of all dyads ($n = 184$) in these six groups, 67% of all pecking and chasing events were observed between cocks. One cock from each of the two aviaries with four cocks and four hens had severe injuries around the eyes caused by aggressive pecks. As a consequence, these cocks had to be temporarily removed from their groups.

3.3. Egg laying places

The quail hens preferred to lay their eggs in cover. The percentage of eggs found in cover (average 91%, range 81–100%, $n = 7$ aviaries) was significantly higher than the proportion of the floor area that was covered with plants and artificial shelters (mean 18%, range 11–25%; Wilcoxon matched-pairs signed ranks test, $n = 7$, $T = 28$, $P < 0.02$). The hens also laid significantly more eggs than expected in the corners and within a zone of 0.1 m along the border of the aviaries (Table 3), while the inner zone of the aviaries which contained an area with wood chips on the floor and no grass or herbs was significantly less used for egg laying than expected.

The hens of a given aviary did not lay their eggs at separate places. Differently patterned eggs were often found within a distance of less than 5 cm from each other. During the study, one hen produced two natural broods with four and five chicks hatching.

Table 3
Spatial distribution of quail eggs in semi-natural aviaries ($n = 8$)

Category	Eggs found (%)	Floor area (%)	P^*
$d \leq 0.1$ m	31.2 (12.5–49.2)	8.0	0.01
0.1 m $< d \leq 0.3$ m	19.6 (0.0–37.6)	15.9	NS
0.3 m $< d \leq 0.5$ m	19.9 (1.5–57.5)	15.1	NS
$d > 0.5$ m	16.1 (0.0–31.6)	59.1	0.01
Corner (0.3×0.3 m^2)	13.2 (1.0–34.1)	1.9	0.05

Four categories were distinguished with regard to the distance (d) between the egg and the aviary's border. Eggs found in a corner were assigned to a special category. Percentages (mean and range) of eggs found in each category and percentages of floor area covered by each category are presented.

* P-values are derived from analysis by the Wilcoxon matched-pairs signed ranks test

4. Discussion

Although the quails used in this study had been reared in cages up to 5 weeks of age their behaviour in the semi-natural aviaries was in many respects similar to the qualitative report of Taka-Tsukasa (1967) on the behaviour of wild quails. In their natural habitat Japanese quail feed on grass-seeds, peas, grains, berries, young shoots, tender leaves, insects and other small grubs (Taka-Tsukasa, 1967). As these food sources are likely to be dispersed, foraging activity probably accounts for a large proportion of the daily activity in wild quails. In the semi-natural aviaries, the quails spent 24% of the observation time on walking/running and 8% on pecking/scratching although they had ad libitum access to food. In a similar time budget study with semi-wild Red Junglefowl, Dawkins (1989) found that the birds also spent much time on walking, pecking and scratching.

Statkiewicz and Schein (1980) quantified the comfort behaviour of Japanese quail kept in a deep litter housing system with artificial light (14L:10D). They reported that the quails spent 10% of the time on preening and 4% on dustbathing. These percentages are similar to the results of our time budget analysis (12% and 2%, respectively). Also in accordance with Statkiewicz and Schein (1980) we observed that dustbathing was most frequent in the afternoon (Schmid, personal observation). Schein and Statkiewicz (1983) found that Japanese quails show high levels of dustbathing when deprivation of a dustbathing substrate is terminated. Dustbathing therefore seems to be of much importance to the quails, and vacuum dustbathing is observed in quails kept in battery cages (Gerken and Mills, 1993). There may, however, be considerable differences in dustbathing activity between strains (Gerken and Petersen, 1987).

The Japanese quail is a migratory bird with an estimated migration distance of 400–1000 km (Wakasugi, 1984). During the breeding season, however, only short flights are observed as an anti-predator response (Taka-Tsukasa, 1967). Flying was also very rare in our study (0.01% of time), and the quails spent almost no time on elevated structures (0.5%). Continuous observations at twilight revealed that quails (unlike chickens) do not perch for rest at night.

Wild Japanese quail are usually found in grasslands, in the bushes along the rivers and in fields planted with rice, oats or barley (Taka-Tsukasa, 1967). In the semi-natural aviaries, we found that the percentage of time the quails spent in cover was significantly higher than the proportion of the floor area that was covered with plants and artificial shelters. The quails' preference for dense vegetation has probably evolved to minimise the risk of predation. When a quail is approached in the wild it first lies still on the ground but then suddenly flies away a few dozen yards and drops into the grass (Taka-Tsukasa, 1967).

In their natural habitat, quails build their nests among the tufts of grass in dry grasslands (Taka-Tsukasa, 1967). In the present study, the hens had a clear preference for laying eggs in cover as well as in the corners and along the border of the aviaries. Stevens (1961) and Orcutt and Orcutt (1976), who investigated the reproductive behaviour of domestic strains of Japanese quail in outdoor aviaries with natural vegetation, also reported that the hens built their nests in concealed sites. It may be possible to take advantage of this preference for the design of nest boxes that can be

built in commercial housing systems. Such nest boxes would probably be shared by several females, as we often found differently patterned eggs laid by different hens in close vicinity.

Taka-Tsukasa (1967) reported that wild quails are found in pairs during the breeding season. In our study, there were 'close relationships' between a given cock and a given hen in groups composed of several cocks and hens. Copulations were frequently observed within such pairs. After the egg laying period all but one 'close relationship' had dissolved. Stevens (1961) also found close associations of a given male with a female throughout nest-building, egg laying and early incubation in domestic quail. It seems that pair formation during the breeding season is a typical trait of the social behaviour of the domestic quail.

The cocks not only built up a 'close relationship' with a preferred hen, but also directed aggressive behaviour at other cocks which resulted in serious injuries in two cases. In more spacious aviaries, the quails would probably spread in pairs and the cocks would keep competitors at distance. On the other hand, we observed very few aggressive interactions between females. We would therefore not expect any problems with aggressive behaviour in all female groups for table egg production and in groups composed of several females and one cock only for brood egg production.

There have been several reports on successful breeding in the domestic quail (Stevens, 1961; Orcutt and Orcutt, 1976; Nichols et al., 1992). Although it was not the aim of the study to observe breeding hens and hence the conditions were not ideal in that respect, one out of 32 hens housed together with cocks produced offspring in our study. Disturbance caused by the presence of several cocks in a group and by regular egg collection during parts of the breeding season were probably responsible for the low incidence of natural broods. In accordance with Stevens (1961) and Nichols et al. (1992), we found that a female can have more than one brood in a year.

In conclusion, our results indicate that, in comparison to the behaviour of the wild quail, the behaviour of the domestic quail has not been profoundly altered by selecting for favoured egg-laying traits and rapid growth. In our opinion, this is of significance for the housing of Japanese quail for egg and meat production. Housing systems that are adapted to the normal behaviour of quails should contain a substrate for scratching, pecking and dustbathing behaviour. Perches are not necessary, but it may be important to provide the quails with cover, as they showed a significant preference to stay in cover, and with nest boxes, as they clearly preferred to lay eggs in cover. In breeding groups injuries caused by aggressive interactions between cocks are likely to be a major problem. Optimal group size and sex ratio have to be identified for such groups. Much more research is needed to transpose the ideas outlined here into alternative housing systems for Japanese quail.

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