

# Welfare of gray partridge kept in adaptive aviaries

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## Summary

The ongoing transformation of the environment, as well as the intensification of agriculture to meet the growing needs of humans, has a negative impact on small game. The drastic decline in the population of the partridge has led to the adoption of various forms of protection, such as restrictions on shooting or supporting the population by introducing new individuals bred in an appropriate manner. Therefore, the aim of the study was to analyze the most frequently displayed behaviors of partridges (*Perdix perdix*) kept in adaptive aviaries. The partridges were observed kept in adaptive aviaries in Hunting Districts of the State Forests "Rawityn" in the Lubartów Forest District and "Suchowola" in the Radzyń Podlaski Forest District from August 18 to September 13, 2023 using wide-angle cameras. The analyzed data were compared with weather conditions. Regardless of the behavior, the birds most often appeared on the recordings between 7:00 a.m. and 3:00 p.m. Partridges spent significantly more time on care behavior (225.81 s) compared to foraging (72.42 s). At lower temperatures, groups were larger compared to birds representing behavior at higher temperatures. The obtained results confirm the tendency of partridges to gather in larger groups during lower air temperatures. Combining into flocks allows birds to survive colder periods, as well as increase safety during the appearance of natural enemies. The welfare of birds was not compromised during their stay in appropriately managed adaptive aviaries.

**Keywords:** *Perdix perdix*, reintroduction, behaviour, welfare

For years the gray partridge (*Perdix perdix*) was considered a common species that did not require protection. Ongoing environmental transformations, as well as the intensification of agriculture to meet growing needs, hurt wildlife (11, 39-42). Moreover, the limitation of the food base, especially in the case of chicks which are highly dependent on animal protein, and the increasing pressure from predators, have led to a sharp decline in the population size of these birds. Unfortunately, data for Poland are consistent with those recorded in almost all of Europe, where a continuous decline in the number of these birds is observed (5). Partridge population declines in the wild have been reported regardless of geographic location, both for Great Britain and continental Europe (1, 18).

The number of partridges in Poland has been decreasing in recent decades, with a particularly steep decline in the 1990s. This resulted in a significant reduction in hunting of these birds, or even cessation in many areas of the country. In the years 2001/2002-2003/2004,

19.3-21.1 thousand partridges were harvested, while in 2011/2012 and 2012/2023 only about 1.2 thousand. During the next eight years, the number of partridges shot was not further reduced, but ranged from 600-900 pieces. However, in 2021/2022, approximately 500 of these birds were obtained in leased districts, and in 2022/2023 only approximately 360 (24).

Apart from the reasons related to the changing agricultural landscape, the decline in partridge numbers is mainly influenced by the percentage of successful breeding and the survival rate of chicks. A series of conducted studies indicate that limiting the number of predators such as foxes, birds of prey and corvids allowed for an increase in the frequency of successful breeding and significantly contributed to improving the survival of young birds (25, 38). Bro et al. (6) study on the partridge population in Great Britain showed that predation was responsible for approximately 70% of losses during the incubation and chick-rearing period. However, an important factor determining the growth

of natural populations of these birds are changing climatic conditions. Especially during the first few weeks of life of young birds. According to data presented by Różewicz and Kaszperuk (32), losses caused by unfavorable weather conditions may amount to up to 60% of the brood.

A significant decline in the number of partridges makes it necessary to take actions aimed at protecting and supporting the reconstruction of the population. This is implemented, among others, by breeding birds in aviaries in the Game Breeding Centers of the State Forests and introducing them to hunting grounds (32). The standard practice for partridge introductions across Europe is to release farm-reared juveniles at the end of summer, usually in groups of 15-100 at 10-12 weeks of age. Apart from occasional cases in which released young birds were spontaneously adopted by wild partridges that had not produced their own young, these birds have been shown to have very low survival rates, high dispersal rates and very low breeding success (7, 29). The main reason for high mortality after introduction is the lack of appropriate anti-predator behaviour, which is not only genetically determined, but also learned from parents (3). The deficiencies in the behaviours learned in the ethogram of farmed partridges mean that the success of reintroduction is often insufficient to obtain a stable population of these birds. On the other hand, in the case of habitats where the presence of adult birds has been found, there is a chance of creating artificial family groups, especially in a situation where pairs have not been successfully breeding on their own.

There is no industrial breeding of partridges in Poland. Consumer needs for meat from these birds were previously met by hunting. However, due to a significant decline in their population in the natural environment, obtaining them by shooting has systematically decreased since the 1980s and 1990s. To this day, activities are carried out to increase the population of these animals. For this purpose, organized breeding farms and reproductive flocks were established, whose task is to obtain chicks and raise them to feed wild populations of this species. At the beginning of the 21<sup>st</sup> century, the number of released individuals, usually from aviary breeding, gradually increased, from 5-6 thousand in 2001/2002-2002/2003 to 36-39 thousand in 2011/2012-2014/2015. Subsequently, however, there was a decline and several thousand partridges were introduced to the leased districts annually, e.g. 11.5 thousand, in 2022/2023 (24). An important element of effective introduction is preparing farm-raised birds for release. One of the elements of breeding is to ensure that young individuals show appropriate behaviour that will allow them to survive in the natural environment, which is why for a certain period they are kept in so-called adaptive aviaries located in a place where they will be released directly into the fishing ground. There are few studies on maintaining the welfare of wild

birds in this type of aviaries. Maintaining welfare is not only for developing strategies to enhance important conditions of birds kept in captivity, but can also have important repercussions on the success of the released animals, as plumage quality, body condition and stress levels may be key for the survival of the birds and, therefore, for the success of restocking practices (8, 16, 19). Therefore, the aim of the study was to analyze the most common behaviours of gray partridges (*Pedrix pedrix*) kept in adaptive aviaries, taking into account agonistic behaviour and stereotypes.

## Material and methods

### The research area

**Hunting districts „Rawityn”.** The area of the hunting district is 8,080 hectares, of which 3,670 ha, i.e. 45%, is covered with forests. According to data from the hunting district, the number of partridges in this area was 280 individuals (as of March 10, 2022). The fishing ground is rich in forest and adjacent meadows with an area of 400 ha. The non-forest part of the fishing area with an area of 4,410 ha consists mainly of arable fields – 65%, including 250 ha of fields with winter plants. A smaller amount of land is managed in the following way: wasteland and fallow land 16%, meadows and pastures 12%, tree plantings 5% and orchards 2% (26).

**Hunting districts „Suchowola”.** The area of the hunting district is 6,816 hectares, with a forest area of 1,945 hectares, i.e. 29.6%. The partridge population as of March 10, 2022 was 150 individuals. The fishing ground has 260 hectares of forest and forest meadows. Additionally, these areas were described in terms of vegetation abundance. They are rich in undergrowth and lichens that cover approximately 90% of the surface. It is mostly a deciduous undergrowth consisting of hornbeam, linden, oak, hazel, willow, buckthorn and maple trees. The non-forest area is 4,871 hectares, of which 65% are arable fields and 20% are meadows and pastures. The remaining 15% were: wasteland and fallow land (5%), woodlots (5%) and orchards (5%) (27).

**Experimental design.** From August 18 to September 13, 2023 10-week-old gray partridges kept in two adaptive aviaries with an area of 400 m<sup>2</sup> were observed, numbering 150 individuals in each. Adaptive aviaries built in the field in Hunting Districts of the State Forests „Rawityn” in the Lubartów Forest District and „Suchowola” in the Radzyń Podlaski Forest District. After opening the gates in the aviaries, the birds left them spontaneously after 4 weeks to join the population living in the wild. In order to protect the livestock, the entire structure was covered with a fine mesh fence not exceeding 3 cm in diameter. In order to prevent predators' access, the net was dug to a depth of 50 cm below the ground. Additional protection was also used in the form of an electric shepherd. Camera traps and observation stands were also installed in the area to identify natural enemies. The aviaries were covered with a dedicated net to protect animals from leaving. The nets were placed at a height of not less than 150 cm to allow animals to fly freely and to facilitate livestock management. The aviaries were planted with vegetation that met the nutritional needs of partridges, including plants commonly found in a given area, in order

to accustom the digestive systems of the acquired animals to the places of introduction. Cereals, small-seeded legumes and Jerusalem artichoke were sown. The aviary has bushes to protect the animals from unfavorable weather conditions. Within the developed area, natural drainage was also made using gravel, which allowed the birds to demonstrate natural grooming behaviour such as sand baths. This will also ensure moisture reduction in the event of excessive rainfall. The area outside the aviary was also developed to better adapt the area to the needs of the introduced birds. The plots were planted with plants providing a diverse food base, as well as shelter and nesting places.

The partridges were fed with a complete mixture dedicated to young partridges, the same as used in commercial breeding and in the same dose from where the animals were purchased. Composition the mixture was: corn, wheat, post-extraction soybean meal, wheat bran, sodium chloride, calcium carbonate, monocalcium phosphate, vitamin and mineral mixtures Table 1, as well as whole grain of cereals: wheat, oats, rye. The birds had access to water *ad libitum*.

**Tab. 1. Composition of the complete feed mixture for young partridges**

Component	Nutrient content per 1 kg of feed
Crude protein [%]	16.0
Raw fiber [%]	5.0
Raw fat [%]	3.0
Calcium [%]	1.0
Phosphorus [%]	0.6
Sodium [%]	0.2
Potassium [%]	1.1
Magnesium [%]	0.35
Iron [mg/kg]	115.0
Copper [mg/kg]	12.4
Manganese [mg/kg]	158.0
Zinc [mg/kg]	58.0
Cobalt [mg/kg]	1.0
Iodine [mg/kg]	0.4
Selenium [mg/kg]	0.3
Vitamin A [IU]	8000
Vitamin D3 [IU]	800
Vitamin E [mg]	55
Vitamin C [mg]	40
Vitamin K3 [mg]	1.2
Vitamin B1 [mg]	5.5
Vitamin B2 [mg]	4.5
Vitamin B6 [mg]	8.8
Vitamin B12 [ug]	12
Folic acid [mg]	1.7
Nicotinic acid [mg]	110.0
Pantothenic acid [mg]	22.4
Choline [mg/kg]	1763.0
Biotin [ug/kg]	257.0
Carotene [mg/kg]	0.4

In addition, the birds had unlimited access to a mineral mixture (fodder chalk) of various gradations throughout the adaptation period. The chalk was available in a separate feeder. Due to the location of the adaptation aviaries, the birds also foraged on the vegetation growing in the aviaries, and had the opportunity to supplement their diet with insects naturally present in the environment.

Observations were made using two wide-angle cameras equipped with a motion sensor but without infrared (therefore no observations were made at night). Cameras were placed inside each adaptive aviary in its opposite corners. Each camera allowed for observation of a different part of the aviary. The materials obtained in this way, saved on memory cards, were analyzed by carefully viewing the material multiple times and writing down the animal behaviour (exploration, foraging, grooming, rest, escape, anxiety, aggression towards individuals in the aviary, stereotypes) accurate to 1 second. During the analysis of the recordings, comments were made regarding the group size, escape speed, and differences in reaction to stimuli (unknown sound, attack by a predatory bird, appearance of dogs and/or humans). The analyzed data were compared with the air temperature occurring at the time of the recorded material, with an hourly accuracy, obtained from archival measurements recorded on the website <https://pogoda.interia.pl/> (13).

**Statistical analysis.** Statistical analyzes of the most common animal behaviours were carried out using SAS 9.4 software (SAS software – Statistical Analysis System, 9.4, 2013). The number of appearances per hour and the number of individuals in the herd (also divided into behaviours) were analyzed using the chi-square test. The group size of birds depending on temperature was analyzed by one-way analysis of variance (PROC GLM) with Tukey's post-hoc test at  $p \geq 0.05$ . Assuming that the average temperature during the observation period was 20.8°C, cold (< 20.8°C) and warm (> 20.8°C) periods were assumed. Straight-line regression was used to change the group size depending on temperature. No precipitation was recorded during the study period.

## Results and discussion

The most common behaviour observed in the studied birds was foraging and exploration, which accounted for 71.5% and 23.6% of all behaviours per aviary, respectively. Partridges spent most of their time grooming, feeding and resting (225.81 seconds, 72.42 seconds and 55.8 seconds, respectively) (Tab. 2).

**Tab. 2. The most frequently demonstrated behaviours and the time of displaying these behaviours by partridges kept in an adaptive aviary**

Behaviour	Demonstrated behaviour in relation to all observed behaviours [%]	Average time spent on the behaviour [seconds]
Foraging	71.5	72.42
Exploration	23.6	–
Rest	1.1	55.80
Care	0.7	225.81
Escape/disturbance	2.6	35.00

Partridges most often, regardless of their behaviour, appeared on the recordings between 7:00 a.m. and 3:00 p.m. (Fig. 1). A similar relationship was also noted in the case of nutrition and exploration behav-

our (Fig. 2). Partridges displaying feeding behaviour most often appeared in the recordings from 7:00 p.m. to 8:00 p.m., and most often explored from 4:00 a.m. to 5:00 a.m. (Fig. 2).

The size of groups foraging or exploring the aviary did not differ statistically significantly. There was a tendency to reduce the number of partridges in the group from 6:00 a.m. to 5:00 p.m., excluding the hours from 8:00 a.m. to 9:00 a.m. (Fig. 2).

There was a statistically significant difference in group size depending on temperature regardless of behaviour. At lower temperatures, exploratory behaviour was observed in groups of 12.45 individuals, and at higher temperatures – 8.78 individuals. There was also a statistically significant difference in the number of groups exhibiting foraging behaviours. On a cooler day, partridges foraged in larger groups (10.45 individuals) compared to warmer periods (7.5 individuals). With an increase in temperature by 1°C, the number of individuals in the group decreased by 0.33 individuals, regardless of the behaviour represented (Fig. 3). Regression equation:  $17.6 - (0.33t)$ .

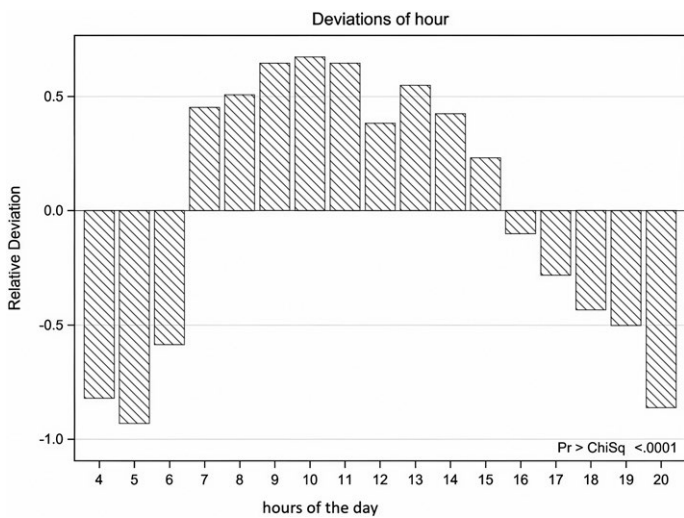


Fig. 1. The number of partridge appearances in the recordings for all behaviours

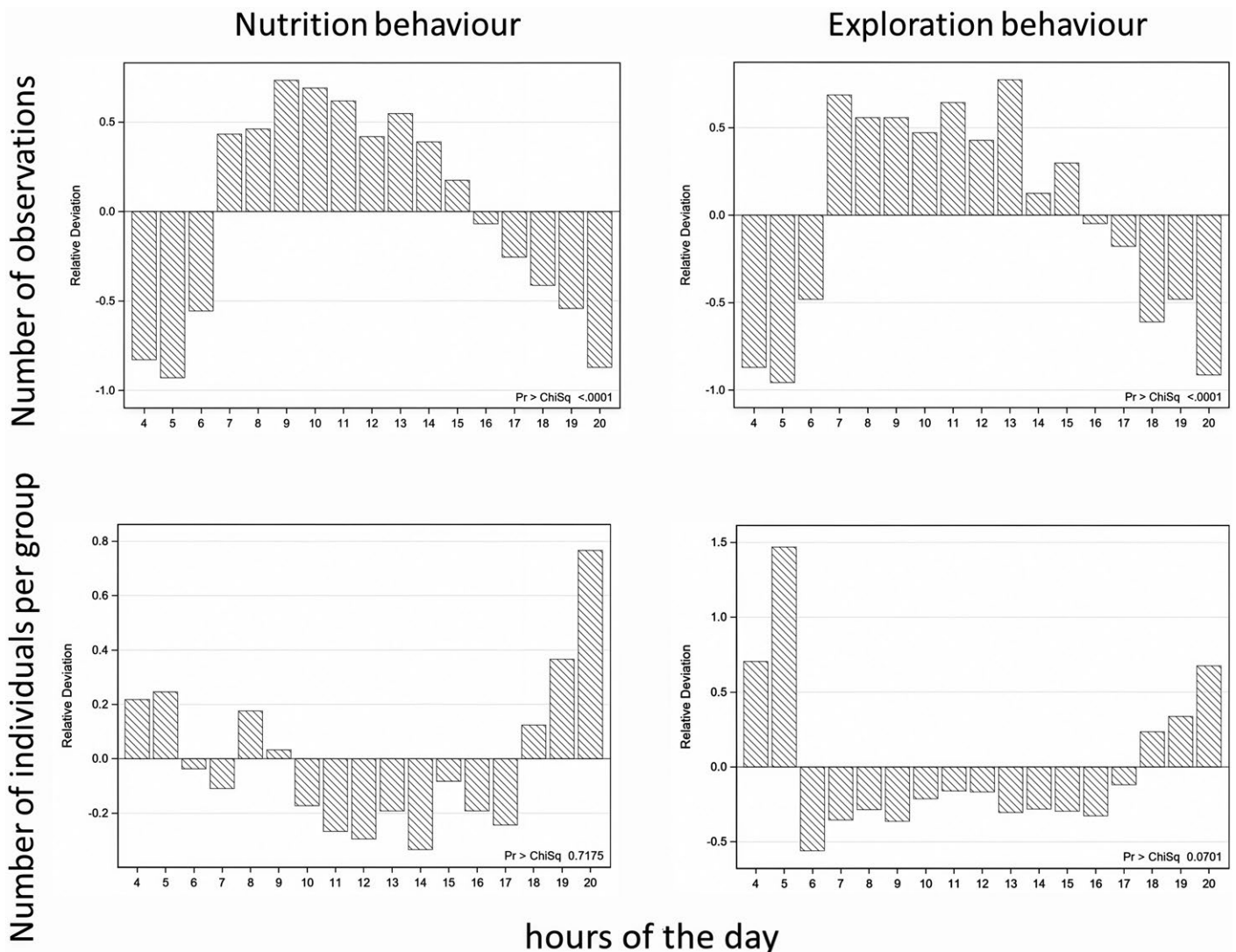
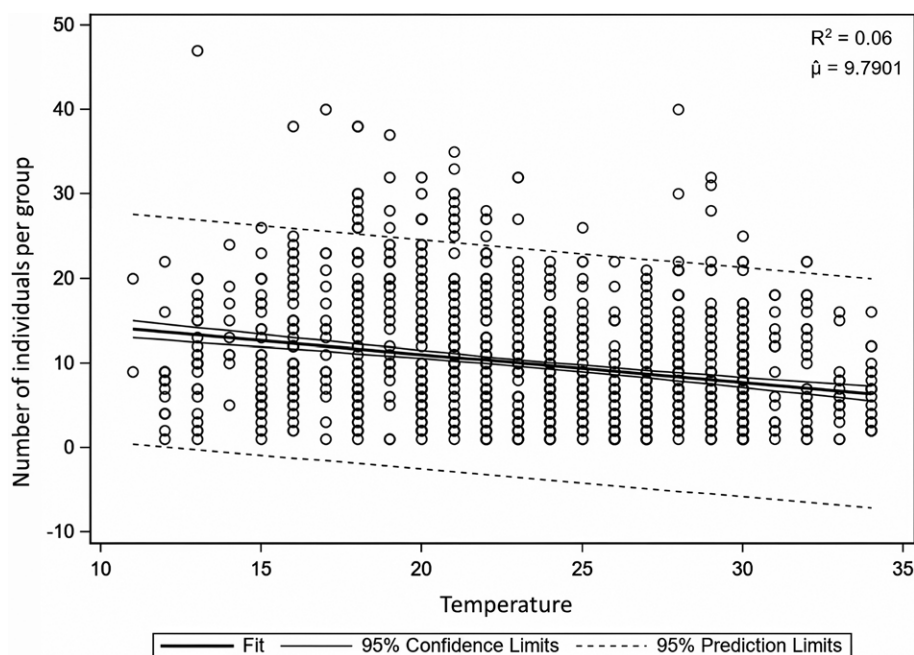
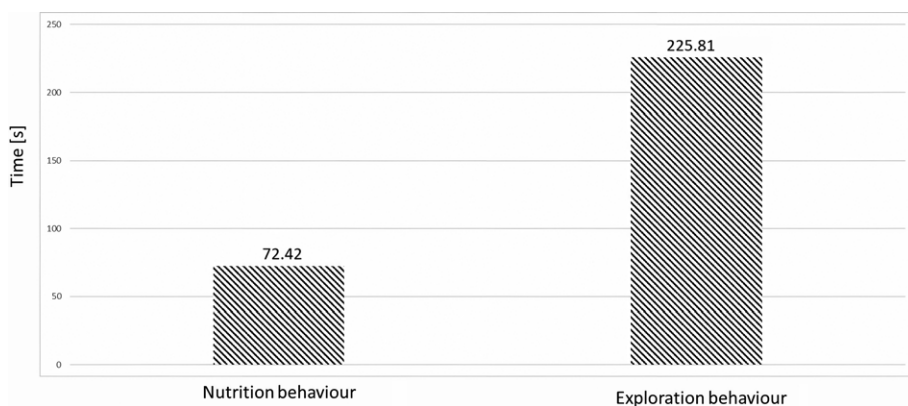


Fig. 2. The number of observations and the number of partridges in the group showing nutrition and exploration behaviour depending on the hour of observation



**Fig. 3. Straight-line regression for change in group size depending on temperature (assuming that the average temperature during the observation period was 20.8°C, cold (< 20.8°C) and warm (> 20.8°C) periods were assumed)**



**Fig. 4. Time spent on exploration and nutrition behaviours (at  $p < 0.05$ )**

Partridges spent significantly more time on grooming behaviours (225.81 s.) compared to feeding behaviours (72.42 s.) (Fig. 4). During the entire observation period, no agonistic behaviour or stereotypes were observed.

The obtained results confirm the tendency of partridges to gather in larger groups when the air temperature decreases. Joining flocks allows birds to survive colder periods and also allows them to stay safe (23, 32). The appearance of partridges in larger flocks in the morning and evening hours is probably related to sleeping in larger and therefore safer groups. However, in the afternoon (12:00-15:00), large flocks broke up into smaller groups that appeared more often in the camera's eye, which resulted from a greater probability of appearing with a larger number of groups. The highest amount of observed exploratory behaviour occurred at 1:00 p.m. This may be caused by the birds preparing for afternoon light exposure. A mixture of sand and soil between the feathers would provide greater ventilation and cool the body. It is worth taking a closer look at this

due to the possibility of coincidences between bathing in the substrate in an area sprayed with insecticides and/or fertilizers on the reproductive capacity or health of both adult birds and chicks, as the skin absorbs many elements on its surface. Another demonstrated tendency is a much longer time devoted to grooming behaviour as opposed to the time spent feeding. Other studies confirm these observations that at this stage there is a development of exploratory and affiliative behaviours among young birds compared to older ones (9, 31). The recordings show that the partridges quickly started feeding and gave up on it in the event of a threat. Partridges exhibiting grooming behaviour, i.e. sand baths, were less willing to leave their places and only did so out of compulsion. This may be related to their relative safety because the position that sticks to the ground and remains in a depression is difficult to observe, and the smell of the ground additionally masks the smell of the bird. Predators' eyes primarily perceive movement, which may confirm this tendency, but it should be subjected to appropriate observation and research. One of the primary approaches to improve the living conditions of animals in captivity is environmental enrichment. It can be defined as the modification of the environments of captive animals to increase behavioural opportunities,

to improve biological functioning and to reduce abnormal behaviours (22, 34, 43). Environmental enrichment, such as including perches, foraging and dust bathing substrates and so forth, has been probed to enhance welfare, activity and improve birds' health.

The partridges did not show any aggressive behaviour towards each other or stereotypes, hence we can assume that the adaptive aviaries were properly managed and met the animals' needs resulting from the display of natural behaviours, such as: specifically vegetation cover, including perches, foraging and dust bathing substrates and so forth, has been probed to enhance welfare, activity, and health for birds (2, 14, 20, 30). Furthermore, the presence of abundant vegetation may provide greater availability and diversity of natural food resources, such as invertebrates, which can enrich the birds' diet (36).

Although animal welfare has recently become one of the hottest topics in animal production, there are few reports on this topic for wild animals. In the case

of research or observations conducted on partridges, there is even less data. However, it should be assumed that the behaviour of these birds should be similar to other representatives of Galliformes (4). Assuming the above-mentioned approach, it should be concluded that the time spent exploring the environment supports maintaining a high level of welfare in adaptive aviaries. This is supported by the research of Hocking et al. (12) and Schütz et al. (35), who unanimously indicate that birds exposed to strong negative stimuli do not show significant interest in the surrounding environment and are characterized by lower activity in the field of environmental exploration.

In terms of adaptation, it is also important to observe the natural defensive behaviour of birds as an element of adaptation to the natural environment. One of its basic manifestations is defensive behaviours such as immobility, active escape or increased vigilance. In the case of the gray partridge, there is evidence indicating a specific pattern of behaviour of these birds in natural conditions. According to Sánchez-García et al. (33), in flocks of partridges two basic warning signals cause a different reaction depending on the type of predator. Research also shows that these birds are characterized by varying levels of vigilance when feeding in groups. According to the data presented by Dahlgren (10) or Beani and Dessi-Fulgheri (3), males are characterized by higher vigilance, which may translate into their effectiveness in finding a partner. These reports may therefore indirectly explain large groups of birds during the day, as an element that increases their safety thanks to the increased vigilance of some individuals. Moreover, gathering in groups is one of the classic social behaviours of this species, especially in the fall and winter, but also in other periods of the year in the case of family groups (15). Therefore, it can be assumed that the appearance of larger groups of birds at the feeding sites, with the simultaneous lack of agonistic reactions, was a natural behaviour for the birds, aimed at increasing the possibility of protection against predators.

An important element of the ethogram of all burying birds are grooming behaviours, such as sand baths, feather combing, etc. Sand bathing is an instinctive behaviour for burying birds, allowing them to get rid of external parasites, but also enabling relaxation and reducing the level of stress (28). This behaviour is so important for birds that research shows that they can devote up to 20% of their activity to it (21). On the other hand, research by Kozak et al. (17) indicated increased cortisol levels in birds exhibiting excessive grooming behaviour. Similar conclusions were also reached by Spruijt et al. (37), who indicate that too much grooming behaviour may be an attempt at relaxation and stress reduction. In our own research, it seems that a large number of care behaviours are caused by both of these reasons. On the one hand, the lack of agonistic behaviour and stereotypes supports

the preservation of welfare and the fact that grooming behaviour is natural, and on the other, it may be a way to deal with stimuli reaching the birds from the external environment. However, both assumptions have the same meaning, suggesting that the aviaries have been designed and located appropriately, and adaptation to the environment is taking place correctly. The welfare of birds in properly managed adaptive aviaries can be maintained, thanks to which the animals can join the wild population in appropriate health and conditions.

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