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ANALYSIS OF THE TERRITORIAL VOCALIZATION RITUAL OF THE COMMON PHEASANT *PHASIANUS COLCHICUS* IN URBAN AREA (LUBLIN, POLAND)

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The study aimed to determine the exact duration of individual stages of the territorial vocalisation ritual of *Phasianus colchicus* cocks living in an urban area. Thorough knowledge of the courtship behavior can be the basis for understanding the mechanisms that influence female's preferences when choosing a cock for mating. The work was performed based on the analysis of film recordings of 7 male pheasants recorded in the Bystrzyca Valley in Lublin (Poland). Several-minute recordings were made from April 19 to June 27, 2018 in the morning (around 6:00–8:00). The characteristic of the species ritual vocalization were divided into four phases. The study concluded that the average duration of individual phases of ritual vocalization within individual birds varies and is an individual value.

Key words: common pheasant, *Phasianus colchicus*, behavior, mating period, territorial vocalization.

INTRODUCTION

The analysis of birds' sounds is an important way to study bird ecology and behavior (Slabbekoorn & Smith 2002, Neal *et al.* 2011). There are very few studies on the acoustic characteristics of pheasants (Heinz & Gysel 1970, Shiren *et al.* 1996) despite the ease of observation of these birds and their characteristic mating ritual with loud vocalization. The common pheasant (*Phasianus colchicus* Linnaeus, 1758), a member of the order Galliformes in the family Phasianidae, is the most widespread pheasant in the world (Chang *et al.* 2008, Kayvanfar & Aliabadian 2015).

The mating system of the pheasant is based on mate guarding, which protects females not only from the risk of predation or injury but also from excessive energy expenditure incurred through being chased by other males. When escorted by a territorial male, females spent three times as much time feeding, one-fifth as much time running, and one-tenth as much time being alert, as they did when not guarded (Ridley & Hill 1987). Along with the arrival of spring, male pheasants designate the territories that they guard and defend against other males. The resident cock emits loud sounds accompa-

nied by stretching the body, flapping wings, tossing their heads, lifting and stretching the tail. This phenomenon, referred to as vocalization, is aimed at attracting females and expelling other males from a given territory. The amount of crowing depends on the density of birds in a given area. During the peak of the breeding season, they are heard even every 10–15 minutes. When territories are close to each other, males from the neighboring areas respond to each other by crowing. Male pheasants that are the most attractive to females exhibit greater territoriality: they move less during the day, have smaller territories, and crow more frequently (Grahn *et al.* 1993*a,b*, Mateos 1998). Females make a selection from the male courtship display probably based on morphology (Göransson *et al.* 1990, von Schantz *et al.* 1994), behavior during courtship (Mateos & Carranza 1999), and even features associated with major histocompatibility complex (MHC) genes (Baratti *et al.* 2012). The sound of a rooster can also provide hens with acoustic information on the physical fitness of the males, which indirectly reflects the quality of the habitat occupied by a male (Slabbekoorn & Smith 2002). The studies on the influence of anthropopressure on the environment and the behavior of wild animals provide a new scientific basis for introducing changes in the regulation of potentially harmful human activities in the environment (Bejder *et al.* 2009, Steven *et al.* 2011, Steven *et al.* 2015). It is important that pheasant cocks, like many male birds (Nolan & Hill 2004, Nowicki & Searcy 2005), present their individual characteristics during the courtship display process through the characteristic singing (crowing) and mating ritual (wing flapping), which consists of specific forms of behavior (Mateos & Carranza 1995). On this basis, the hens make the choice of a partner, which is a natural selection for the reproduction of individuals with the desired phenotypic characteristics. On the one hand, the courtship ritual of the pheasant is a form of luring as many hens as possible. Furthermore, it is a signal to other males to occupy a given territory and eliminate potential rivals in the fight for breeding (Mateos 1998, Rogers & Kaplan 2002). Thorough knowledge of the courtship behavior can be the basis for understanding the mechanisms that influence female's preferences when choosing a cock for mating. Therefore, the study aimed to analyze the ritual of territorial vocalization of pheasant cocks in an urban area.

MATERIAL AND METHODS

The work was based on film recordings of 7 male pheasants (*Phasianus colchicus*) recorded in the urban area in the Bystrzyca Valley in Lublin (Poland). The observations of the mating ritual lasted approximately 20 minutes for each individual and were repeated on consecutive days (at least 9–12 times/pheasant; the specific number of observations (n) for each male is shown in Table 1 covering the period from 19 April to 27 June 2018 in the morning hours (around 6:00–8:00). The behavior of the males was video-recoded with a Panasonic HC-V180 Full HD Camcorder (Panasonic Marketing Europe GmbH South-East

Europe). The recordings were analyzed frame by frame with the use of Cyber Link Power Director (version 18.0.2402.0), in which the duration of consecutive behaviors forming the mating ritual was analyzed. The observation of the vocalization ritual allowed us to distinguish four separate phases of this behavior. The duration of these phases was determined for all rituals of the individual cocks.

Statistical analysis of the research results was carried out with the use of Statistica 13.1. Compliance of the distributions of the examined traits with normal distribution was assessed with the Shapiro-Wilk test. Since the distributions of the analyzed dependent variables (length of individual phases of the pheasant vocalization ritual) significantly differed from normal, non-parametric (ranks) tests were employed to analyze the significance of the differences between these distributions. A non-parametric analysis of variance (Kruskal-Wallis test) was used to compare the values of variables between the individuals. The description of the distributions were based on the measures of position: median and quartiles. If significant differences between the groups were found, the result of the multiple-comparison test (post-hoc) of mean ranks for all groups with Bonferroni adjustments was marked with uppercased small letters. Groups that share the same letter do not differ significantly, whereas there are significant differences between groups that are not marked with the same letter.

RESULTS

The observation of the ritual of vocalization in the cocks allowed distinguishing four separate phases that comprise specific behaviors occurring in each observed individual (Fig. 1):

- The first phase (Fig. 1*b*) – flutter before vocalization, i.e. the period from spreading to folding the wings during waving before vocalization; average duration 0.368 s (n = 76; SD = 0.059; range = 0.260-0.460).
- The second phase (Fig. 1*c*) – vocalization, including straightening and crowing; average duration 0.370 s (n = 76, SD = 0.100, range = 0.220–0.540).
- The third phase (Fig. 1*d*) – flutter after vocalization, i.e. the period from unfolding to folding the wings during waving after vocalization; average duration 0.939 s (n = 76, SD = 0.1123, range = 0.760–1.180).
- The fourth phase(Fig. 1*e*) – ruffled feathers with a raised tail and return to the basic posture; time measured from the moment of folding the wings to vocalization to the point where the pheasant looks neutral and has a drooping tail; average duration 1.498 s (n = 76, SD = 0.661, range = 0.460–3.400). In some individuals, additional behaviors were found in this phase, such as the correction of the position of one or both wings and head swings.

The analysis of observations has shown that the duration of the entire ritual was, on average, 3.176 seconds (n = 76, SD = 0.606, range = 2.82–3.48) (Fig. 1). The non-parametric of Kruskal-Wallis variance analysis showed significant differences related to individual differences in the duration of the entire ritual (χ^2 = 25.988, df = 6, p = 0.0002) (Table 1), suggesting that the ritual is characteristic to

the individual cocks. On average, the shortest duration was recorded in phase 1, i.e. the flutter of the wings before vocalization, whereas phase 4, i.e. the return to the basic posture, was the longest (Fig. 2). There were also significant individual differences in the average duration of the particular phases included in the ritual

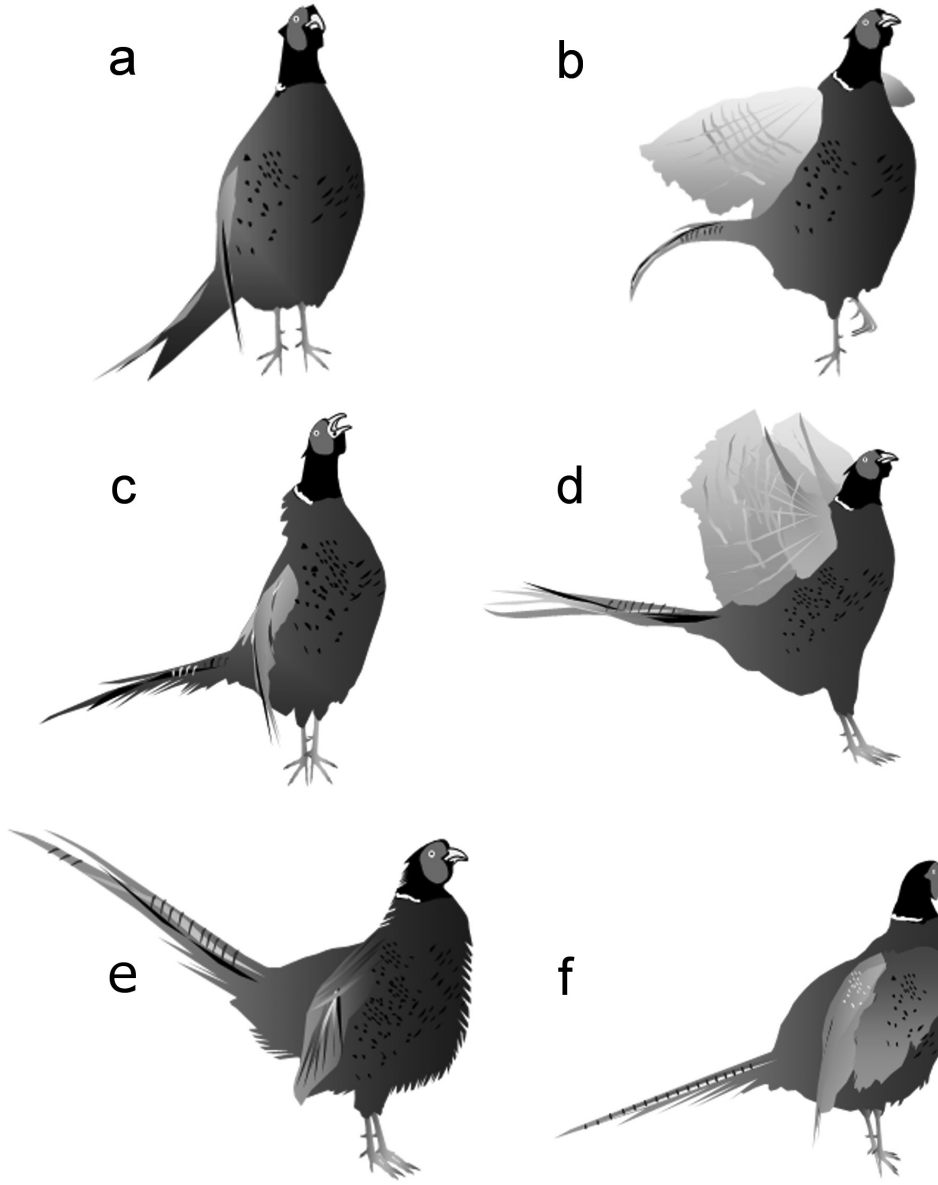

Fig. 1. Phases of the vocalization ritual. a = before vocalization, b = Phase 1, c = Phase 2, d = Phase 3, e = Phase 4, f = after vocalization

Table 1. Distribution of the analyzed variables of the individual pheasant cocks (median, Q25–Q75, n).

ID of individual	1	2	3	4	5	6	7	p-value
Total time of the vocalization ritual	3.48^{a} (3.16–3.68) 12	3.36^{a} (2.88–4.02) 12	2.85^{b} (2.70–3.00) 12	3.06^{a} (2.80–3.72) 9	3.48^{a} (2.00–4.96) 10	2.84^{b} (2.36–3.00) 11	3.08^{a} (3.00–3.16) 10	0.0002
Phase 1	0.42^{a} (0.38–0.42) 12	0.41^{a} (0.38–0.42) 12	0.36^{abc} (0.34–0.40) 12	0.32^{bd} (0.28–0.36) 9	0.28^{cd} (0.26–0.31) 10	0.36^{abc} (0.32–0.46) 11	0.42^{ab} (0.30–0.46) 10	0.0001
Phase 2	0.27^{a} (0.24–0.28) 12	0.34^{abc} (0.32–0.34) 12	0.30^{abc} (0.22–0.50) 12	0.46^{acd} (0.22–0.48) 9	0.45^{cd} (0.40–0.48) 10	0.50^{d} (0.38–0.54) 11	0.38^{acd} (0.28–0.42) 10	0.0001
Phase 3	0.96^{ab} (0.96–0.98) 12	0.81^{c} (0.78–0.84) 12	1.00^{ad} (0.88–1.06) 12	0.84^{bcd} (0.82–0.86) 9	0.82^{c} (0.76-0.85) 10	1.06^{a} (1.04-1.14) 11	1.05^{a} (0.96-1.14) 10	0.0001
Phase 4	1.84^{abc} (1.50-2.02) 12	1.80^{abd} (1.30-2.46) 12	1.00^{def} (0.93-1.56) 12	1.64^{abd} (1.22-2.08) 9	1.87^{abd} (0.56-3.40) 10	0.92^{eg} (0.46-1.02) 11	1.31^{be} (1.02-1.50) 10	0.0025
Average number of wing flaps before vocalization	3.0^{a} (2.0–3.0) 12	2.0^{ab} (2.0–2.0) 12	2.0^{a} (2.0–3.0) 12	2.0^{ac} (1.0–2.0) 9	1.0^{cd} (1.0–1.0) 10	2.0^{ac} (2.0–2.0) 11	1.0^{bcd} (1.0–2.0) 10	0.0001
Average number of wing flaps after vocalization	9.0^{ab} (9.0–9.0) 12	7.0^{c} (7.0–8.0) 12	8.0^{bc} (8.0–9.0) 12	8.0^{bc} (8.0–9.0) 9	7.0^{c} (7.0–8.0) 10	11.0^{a} (11.0–11.0) 11	9.0^{ac} (8.0–9.0) 10	0.0001

of vocalization (Fig. 2, Table 1). This finding also indicates that the duration of the vocalization phases in individual males are specific to each animal.

The number of wing flaps before the vocalization was 1.9 (n = 76, SD = 0.68, range = 1–3), and was 8.6 (n = 76; SD = 1, 30; range = 7–12) after the vocalization. Further analysis showed that the mean number of wing flaps both before the vocalization (Kruskal-Wallis: χ^2 = 29.419, df = 6, p = 0.0001) and after the vocalization (χ^2 = 47.655, df = 6, p = 0.0001) were significantly different among the individuals (Table 1).

DISCUSSION

Our study showed differences in the ritual of vocalization in various individuals, which indicates that this is an individual feature in pheasant cocks. In the studies of Luukkonen *et al.* (1997), the frequency of pheasant crowing was not related to the subspecies, age, year, and weather variables. A three-year study conducted by Heinz and Gysel (1970) on the structure of pheasant vocalization using spectrographic analysis showed that inter-individual variation in crowings greater than intra-individual variability and, therefore, it is possible to distinguish specimens on the basis of an accurate

spectroscopic analysis. In studies on the acoustic features of partridges (*Perdix perdix*) (Rotella & Ratti 1988), a significant variation in the structure of vocalization was found, depending on the season of the year. The study of Xiaojun *et al.* (1995) on captive pheasants showed that the time budgets between males and females were significantly different. Moreover, the time budgets of captive pheasant were influenced by sexes, age, the stages of the breeding season, group size, and food supply. The influence of the breading season was shown in adult captive Green peafowl (*Pavo muticus*), where courting display activity occurred more frequently from November to May than the rest of the year (Jun *et al.* 1996). As our research and others (e.g. Mateos & Carranza 1997) have shown, the mating ritual consists of many components, each of which can play an important role in luring hens and dominating rivals.

When selecting males, the hens are also guided by appearance characteristics of males (Papeschi & Dessì-Fulgheri 2003), including the length of spurs in older cocks (Grahn & Von Schantz 1994). The dominant males are in better condition and more resistant to parasites (Hillgarth 1990) and, as shown by the study Hoodless *et al.* (2002), specimens infected with ticks (*Ixodes ricinus*) have less success in harem formation than healthy specimens. According to Mateos & Carranzo (1997, 1999), permanent signaling of a dominant

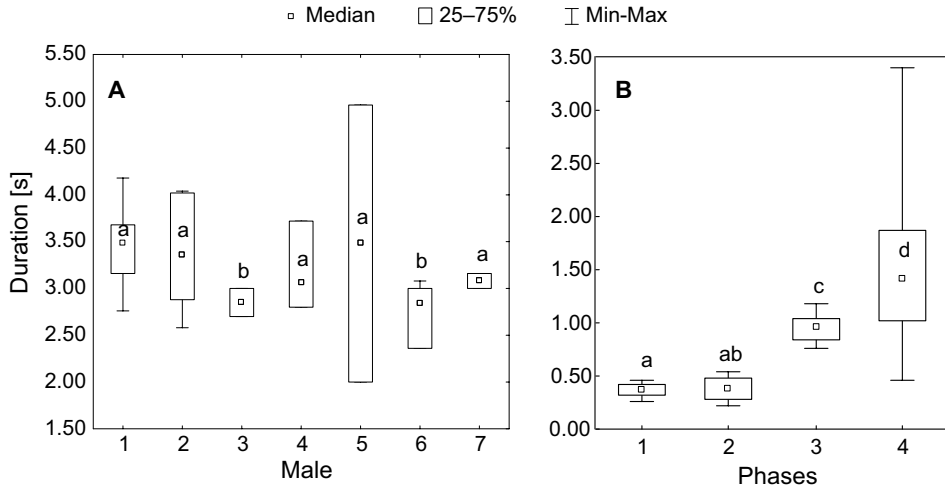

Fig. 2. A = Median duration [s] of the entire ritual of vocalization. a, b – The values marked with different letters within each male differed significantly with $p \leq 0.01$ (non-parametric analysis of variance Kruskal-Wallis test, $\chi^2 = 25.988$; df = 6; p = 0.0002). B = Median duration (s) of the individual phases of vocalization. [a], [b] – The values marked with different letters within each studied phase differed significantly with $p \leq 0.01$ (non-parametric analysis of variance Kruskal-Wallis test, $\chi^2 = 280.95$; df = 3; p = 0.0001)

position by roosters during the breeding period is very costly and may result in increased mortality in territorial cocks (Grahn 1993).

We conducted our research in an urban area (Lublin, Poland) and, as reported by Slabbekoorn and Boer-Visser (2006), the urbanization and the continuous growth of noise in cities adversely affect the reproductive behavior of many bird species, interfering, among other things, with the territorial structure of species that determine their territories based on vocalization. The results of our work conducted in urban areas can be the basis for comparisons with pheasant populations inhabiting agricultural areas. An increasing number of studies indicate changes in vocalizations of different animal species as a result of exposure to anthropogenic noise and show differentiation of acoustic signals between populations of the same species in urban and non-urban habitats (Sun & Narins 2005, Dowling *et al.* 2011, Lampe *et al.* 2012, Colino-Rabanal *et al.* 2016).

CONCLUSIONS

We have shown that the mating ritual consists of many components, whichever can play an important role in luring hens during the mating season. The length of the mating ritual and its certain components, such as the number of wing flaps are the individual feature. However, at this stage of the research, we cannot draw any more far-reaching conclusions, so that the research will be continued with an extension to populations from agricultural areas. We believe that this type of research into the behavior of species inhabiting urban areas makes an essential contribution to understanding the behavioral changes in this species.

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Compliance with ethical standards.

Conflict of interest: The authors declare that they have no conflict of interest.

Ethical approval: All applicable international, national, and/or institutional guidelines for the care and use of animals were followed. All procedures performed in studies involving animals were in accordance with the ethical standards of the institution or practice at which the studies were conducted. This article does not contain any studies with human participants by any of the authors. This study is observational and did not involve captive animals or experimental manipulations, only analyses of video material collected for the study.

Data availability: The data sets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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