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Preliminary data on the activity of male and female common pheasants *Phasianus colchicus* during the breeding period in a Mediterranean area

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Abstract - Assessing patterns of activity rhythms in wildlife is pivotal for species conservation. In this work, we aimed at determining the curve of activity rhythms of male and female common pheasants *Phasianus colchicus* in a Mediterranean area in central Italy. We used camera-trapping and we computed the inter-sexual temporal overlap of activity rhythms in the breeding period. We collected 129 independent records of common pheasants (males, N = 90; females, N = 39). Males were mostly active in the morning, whereas female activity was mostly concentrated at dawn and dusk, showing an intermediate overlap of diurnal activity rhythms (Δ_1 = 0.55). Recorded patterns of activity rhythms confirmed the importance of ecotones for the conservation of this species, which represent an important prey for several native carnivores.

Keywords: Activity rhythms; camera traps; Galliformes; game birds; *Phasianus colchicus*.

INTRODUCTION

Assessing patterns of activity rhythms of animal species is pivotal both for conservation and for wildlife management (Lovari & Rolando 2004, Refinetti 2008). However, determining peaks of activity rhythms is challenging, due to the logistic constraints to observe targeted taxa in all the habitat types where they live, including dense forests and thick scrublands, and throughout the 24 hours (Lovari & Rolando 2004, Zwerts et al. 2021). Up to now, camera-trapping to determine activity rhythms has been applied mostly to medium- and large-sized terrestrial mammals (O'Connell et al. 2011, Lynam et al. 2013). When applied to birds, camera-trapping has been used to assess occurrence, occupancy, or parental behaviour at nests (O'Brien & Kinnaird 2008 for a review; Anile et al. 2022). Nevertheless, together with non-flying birds (Ratites), some bird groups spend most of or the whole of their active time foraging on the ground, including waders and Galliformes (Tran et al. 2021). Camera-traps have been also used to describe patterns of activity rhythms of some galliform species, mostly in tropical countries (Mohd-Azlan & Engkamat 2013, Fan et al. 2020, Pla-Ard et al. 2021). The common pheasant *Phasianus colchicus* is native to Central and Eastern Asia and it has been introduced for hunting to most of Europe, North America and Oceania (BirdLife International 2016). The breeding period of this species in Italy extends from March to early September (Genovesi et al. 1999). In spring (mid-March to early June) males establish breeding territories, which are actively defended from other males. On the other hand, females are not territorial. Each female typically has a seasonally monogamous relationship with one territorial male, which is polygynous (Venturato et al. 2009). Female common pheasants tend to choose dominant and bright males (Venturato et al. 2009). Then, females create shallow depressions in the ground in densely-vegetated areas, where they lay one egg/day up to 7-15 eggs. Afterwards, females remain close to the nest, incubating the eggs for most of the day, leaving only to feed. Each female breeds no more than once a year, with an average time to hatching of 25 days (cfr. Genovesi et al. 1999).

Ecological needs include food and cover availability for both sexes (Genovesi et al. 1999, Nelli et al. 2012), with males defending territories (Ridley & Hill 1987, Hill & Robertson 1988, Riley et al. 1998). The common pheasant is a highly sexually dimorphic species, with males being 30-40% larger than females (Wittzel 1991) and showing an ornamented, bright and coloured plumage, long tail, red wattle and ear-tufts. Females are cryptic and non-ornamented, as they search for food need to be camouflaged to keep predators far from nests and chicks/juveniles. Conversely, bright males are highly visible to predators, although the cost of natural selection is lower than the benefits provided by sexual selection. Therefore, they may need to find a trade-off between their spatiotemporal behaviour and the avoidance of predators and, potentially, hunters (Mori et al. 2017).

Only little information is available on the patterns of activity rhythms of the common pheasant, although the species is anecdotally reported to be diurnal (Dalke 1937). Venturato et al. (2010) carried out radiotracking only during the daylight and showed that pheasants were active in daytime. Genovesi et al. (1999) reported that pheasants tend to use cover habitats (e.g., wooded areas, scrublands) at night and in the central hours of the day, whereas being active in feeding habitats mostly at dawn and dusk, although their activity rhythms have never been described in detail. However, no data on activity peaks and sexual differences occurs whereas, given the remarkable sexual dimorphism, some differences in ecology and behaviour have been suggested (Ridley & Hill 1987, Mateos & Carranza 1999, Venturato et al., 2010). Intersexual differences in plumage colours may reflect differences in behaviour between male and female pheasants.

Given the limited flight performances of the common pheasant (Robertson et al. 1993, Tobalske & Dial 2000) and the main feeding activity on the ground (Doxon & Carroll 2010), aim of our work has been to assess the patterns of daily activity rhythms of male and female common pheasants by means of camera-trapping (Lashley et al. 2018). We predicted that (*i*) activity would be primarily concentrated in daytime with a peak at dawn and dusk (cfr. Genovesi et al. 1999), and that (*ii*) males and females would show different patterns of activity, with males more active in dark hours (i.e., immediately before sunrise and immediately after sunset), as being less cryptic than females.

MATERIAL AND METHODS

Study area

We conducted our field-work in March-August 2020-2021, i.e., during the breeding period of the common pheasant, in the surroundings the Gabellino plateau, in Southern Tuscany, Central Italy (43.083° N, 10.989° E; 1350 ha, 475–903 m above sea level). Local pheasant releases for hunting purposes mostly occur after the breeding period; therefore, our study was conducted on naturalized birds, possibly born wild. In our survey period, the mean annual rainfall was 670 - 26 mm and the mean annual temperature was 15.9 ±7.7°C. Over 60% of the study area was covered with deciduous woodlands (*Quercus cerris* L., *Castanea sativa* Mill., *Ostrya carpinifolia* Scop., and *Carpinus betulus* L.). Scrubland (*Juniperus communis* L., *Rubus* spp., and *Spartium junceum* L.: about 2%) created a sort of belt around woodlands. Open habitats, i.e., fallows and cultivations (mostly sunflowers and cereals), covered respectively about 25% of the study area. The study area hosts a rich community of vertebrate species, with over 30 mammal species and near 100 species of birds (Vannini et al. 2013, Mori et al. 2014). Ecotones between forest/shrubs and open areas were characterised by areas without vegetation or with low plants such as field roads or ploughed strips, i.e. where visibility for camera-traps was the highest.

Camera trapping

Our sampling design consisted in 12 camera-sites active continuously (Mori et al. 2021). We placed one camera trap (Multipir 12 Scouting Camera) per site. Sites were separated from one-another by at least 300–500 m, to increase independence of records, as the greatest home range size of the common pheasant in Mediterranean countries (i.e., areas rich in food resources) include smaller areas (around 2 ha.) throughout the year (Ashrafzadeh et al. 2021). Common pheasants may have also larger home-range sizes (e.g., 0.11-0.55 km^2) where environmental heterogeneity is low (Draycott et al. 2009, Mayot et al. 2017), but, given the local high habitat heterogeneity (Vannini et al. 2013), we suggest that home-range size would be smaller and comparable with those described by Ashrafzadeh et al. (2021). Camera traps were placed in all four major habitat categories in the study area (see Figure 1): open areas (fallows or cultivations, N = 3 sites), scrublands (N = 3 sites), woodlands (N = 2 sites) and ecotones (N = 4, 2 on the side of open areas and 2 on the side of the woodland/scrubland: Mori et al. 2021). Camera traps were tied at trees with ropes and chains. Cameras were located on the closest tree to points selected with QGIS (QGIS Development Team 2019) through a habitat-based stratified randomization of sampling points, to sample all habitat types proportionally to their local availability. Cameras were placed at a height of ~70–100 cm from the ground level and they were activated 24 h/day, to record one video of 60 s/event for 47-62 days per season. All cameras were hidden with local vegetation (e.g., pieces of tree branches and herbaceous plants) to reduce neophobic reactions by animals. We avoided placing camera traps in front of known roosts and nesting sites to avoid (1) disturbance and breeding failures (Herranz et al. 2002, Richardson et al. 2009) and (2) continuous activation of camera-traps. Our cameras were placed at least at 80-100 metres from known nests. Checks of cameras occurred once every 10 days to download data and replace empty batteries. We did not record any camera trap failure (e.g., batteries) or damage.

Figura 1

Statistical analysis

Analyses were carried out on the total year scale. For all pheasant videos, we reported the date and the solar hour, directly shown on the video, on a dataset. Records were also divided by sex of individuals. We limited pseudoreplication bias by counting as one "independent event" all videos of male or female pheasant taken by the same camera trap in less than 30 min (Monterroso et al. 2014, Viviano et al. 2021, see also Lashley et al. 2018 for the wild turkey *Meleagris gallopavo*), keeping in our dataset only one record, placed in the mid-time between the first and the last video. We used the software R (version 3.6.1., R Foundation for Statistical Computing, Wien, Austria: www.cran.r-project.org), package "overlap" (Meredith & Ridout 2014) to estimate activity rhythms and patterns of inter-sexual temporal overlap. We computed the coefficient of overlapping

Figure 1. Camera-trap records of the common pheasant in our study area.

(Δ) between temporal activity patterns of male and female pheasants. The coefficient of overlapping ranges between 0 (no overlap) and 1 (total overlap: Linkie & Ridout 2011, Meredith & Ridout 2014). We calculated the Δ_1 estimator as one of the samples of the comparison (i.e., female pheasant, cf. Results) was < 75 records (Linkie & Ridout 2011, Meredith & Ridout 2014). The 95% confidence intervals (hereafter, 95% CIs) of the coefficient estimator were estimated using 10,000 bootstrap replicates. Overlap was "intermediate" with Δ included between 0.50 and 0.75 was considered as, "high" with Δ > 0.75, "very high" with Δ > 0.90 (Viviano et al. 2021). The Hermans-Rasson *r* test was computed through the package "CircMLE" (Fitak 2020), to assess whether the common pheasant showed a random activity pattern over hours of captures (Landler et al. 2019). "Night" was defined as the period included between 1 h after the sunset and 1 h before the sunrise (Lazzeri et al. 2022). We got the sunset and sunrise with the package "suncalc" in R (Thieurmel et al. 2019), and we considered as crepuscular hours the range time when the sun is between 12° and 0.833° below the horizon (Lazzeri et al. 2022). The remaining part of the 24h cycle was defined as "daylight".

RESULTS

We collected a total of 129 records of common pheasants (males, N = 90; females, N = 39: Supplementary Material 1), at 8 out of 12 camera-trap sites, 83.45% in daylight hours and 16.55% in crepuscular hours. At each camera trap, we were

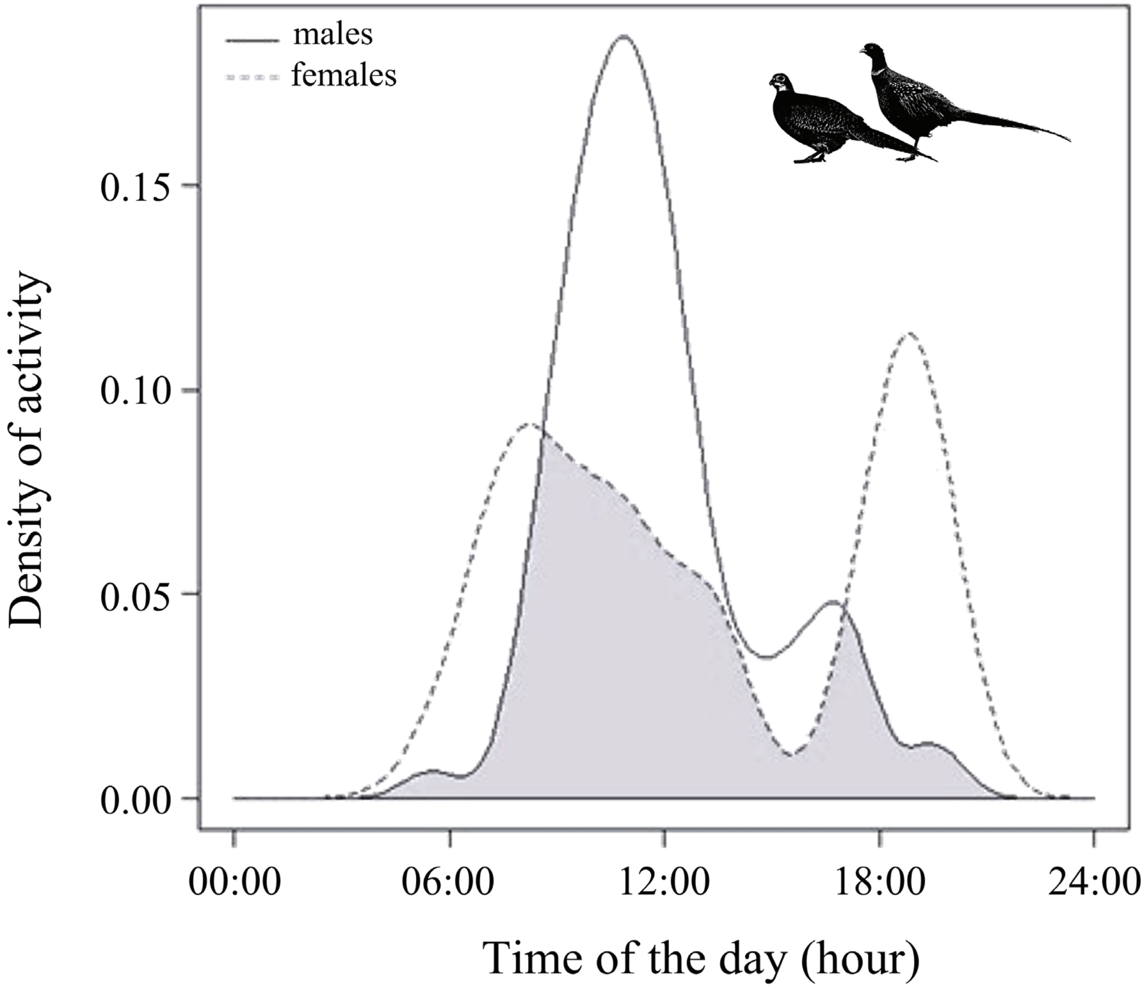

Figure 2. Overlap of activity patterns between male and female pheasants (March-August).

able to identify at least 3.62±1.41 individuals (mean ± SD, range: 2-6 individuals), based on sex, body size and tail length.

Our small sample size prevented us to distinguish between activity in the pre-egg laying period, and in the chick-rearing period.

Records were mainly from ecotone and open areas (100 events from 6 camera-traps), with few events from scrublands (21 events from 1 camera trap) and woodlands (8 events from 1 camera trap). All records from scrublands and woodlands, (i.e., the 3.1% of the total records) were obtained in crepuscular hours.

Activity of both males and females showed a non-random pattern throughout the 24h cycle, peaking in late morning around 10:00-11:00 for males, whereas females showed a double peak in crepuscular hours (Hermans-Rasson test: r = 69.9-75.2, $P < 0.05$). We recorded an intermediate overlap of activity rhythms between males and females during the breeding period ($\Delta_1 = 0.55$, 95%CI = 0.44-0.75: Figure 2). Males and females were sometimes recorded together, particularly in early morning (in 93% of records with a male and a female together).

DISCUSSION

Our work showed for the first time the patterns of activity rhythms of the common pheasant, a common game species. In our study area, the species showed a bimodal pattern during the breeding period, with the first significant activity peak in the morning and other at sunset, i.e., at about 19:00. Records were mainly from ecotones and open areas, with few events from scrublands and woodlands, which are habitat types used mostly for resting (Genovesi et al. 1999, Ashoori et al. 2018), and where it is much more complicated to obtain records from camera traps. Our data suggested an intermediate activity overlap between males and females. In detail, females are mainly active on the ground at crepuscular hours, whereas males showed a peak of activity in late morning, in contrast with our hypothesis. However, patterns of activity rhythms are in line with the sexual selection behaviour described for the species (Mateos 1998). Male ornaments are signals directed both to females and other competing males, influencing the decision-making processes of females and the results of male-male encounters (Mateos 1998). Therefore, territorial male sexual traits need to be well-detected, thus resulting in an increased activity in light hours, which may explain our results (Ridley & Hill 1987). However, male pheasants may limit their movements in late morning or afternoon to reduce the probability of encounters with humans, as well as to avoid the hottest hours of the day in spring and summer. Conversely, females may be active mostly in crepuscular hours, as the best trade-off between reducing predation risk (i.e., when predators are the least active, see Viviano et al. 2021, for the red fox in the same study area) and satisfying nutritional needs. The total activity peak in the morning (mostly due to male activity) confirmed the behaviour observed through camera-trapping for another sexually-dimorphic pheasant species, the blood pheasant *Ithaginis cruentusbe*, during the breeding period (Fan et al., 2020). This increased activity by bright and ornamented males in light hours may be linked to the fact that most predators (i.e., cats, foxes), apart from diurnal raptors and the pine marten, are nocturnal (see Viviano et al. 2021, for the same study area). The lower number of female camera-trap events with respect to males may depend on the fact that females are active in thick scrublands where positioning camera-traps may be challenging (Smith et al. 1999). However, we also placed our camera traps in dense bramble and broom scrubs, where no pheasant was recorded (Mori et al. 2021); therefore, we are confident that our analysis showed reliable results.

Moreover, our dataset was limited to the only breeding period; therefore, we cannot rule out that a seasonal effect on activity patterns of the common pheasant may occur. Furthermore, future research with an increased sample size in each habitat type would help to detect whether habitats influence activity patterns by this species. According to Genovesi et al. (1999), time of the day (i.e., hours) may influence habitat use by pheasants, with cover habitats (mostly above the ground, e.g., on tree branches) mostly attended at night and in the hottest hours of the day (i.e., early afternoon), and open habitats for feeding mostly used at dawn and dusk (Dalke 1937).

We are aware of the limitations due to our low sample size, particularly for females, which have secretive habits and spend most time in cover habitats (tall grasslands) to protect broods. Moreover, camera-traps are effective in open places, but species detection could be considerably reduced in dense vegetation areas, which may have produced some bias in our results.

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DECLARATIONS

Research ethics All procedures performed in this study did not involve animal handling and were in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of interest Authors certify that they have no affiliation with or involvement in any organization or entity with any financial or non-financial interest in the subject matter or materials discussed in this manuscript. Thus, they have no conflict of interest to declare.

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