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# Camera Trap Survey of Two Pheasant Species in the Crocker Range Biosphere Reserve

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## ABSTRACT

Both the crested partridge (Rollulus rouloul) and great argus (Argusianus argus) are at high risk of extinction due to habitat loss and illegal hunting. While these relatively large pheasant species could be monitored using camera traps, such studies have been infrequent in the inland forests of Sabah. To help fill this gap, a camera trap survey was conducted at the Inobong Substation of the Crocker Range Biosphere Reserve to document their local activity patterns. Ten sampling points were established, with each spaced at least 200.0 m apart and 5.0 m away from local hiking trails and vehicle roads, with one camera trap deployed at each point. Over 675 camera trap nights, the great argus predominantly passed through the points, while the crested partridge mainly engaged in foraging behaviour. Both species were detected either individually or in groups of varying sizes and sex compositions, with the crested partridge exhibiting a larger average group size compared to the great argus. Although their overall diurnal activity patterns were highly similar, the crested partridge showed peak activity during different daylight hours compared to the great argus. This highlights a subtle form of temporal niche partitioning, likely due to interspecific competition for movement space, shelter, and food at the sampling points. Ultimately, the present results support the feasibility of employing camera traps for long-term monitoring of these two pheasant species in the inland forests of Sabah, although

further assessment is required to address the limitations of this preliminary research.

## INTRODUCTION

In Borneo, 14 bird species from the Phasianidae family (Ground-living birds) are identified within local forest ecosystems, with half of these species currently threatened by illegal hunting and/or habitat loss (Phillipps and Phillipps, 2014; IUCN, 2025). Among these seven threatened species are the great argus (Argusianus argus) and crested partridge (Rollulus rouloul), both of which are classified as vulnerable (Birdlife International, 2020 and 2021). These two pheasant species are forest specialists and terrestrial insectivore-frugivores (TIF) that mainly forage during the daytime (7.00 a.m. to 5.00 p.m.) and roost in trees at night (7.00 p.m. to 5.00 a.m.) (Wielstra et al., 2011; Phillipps and Phillipps, 2014). Given their similarities in feeding guild, habitat preferences, and diel activity patterns, it is possible that these two species compete for food and shelter within their shared habitats (Chen et al., 2019; Lim et al., 2023). Such interspecific interactions can also trigger smaller species to avoid shared habitat areas during the peak activity hours of their larger competitors, though the extent to which this dynamic impacts the diel activity patterns of birds remain understudied in Borneo (Yahya et al., 2016; Lim et al., 2023).

The activities of these two pheasant species in Borneo can be effectively monitored using camera traps, as their relatively large body sizes render them easily detectable by such devices (Samejima et al., 2012; Jati et al., 2018; Ramadhanti et al., 2025). Nonetheless, such research remains scarce in Sabah, Malaysia Borneo, thereby leading to limited data on their presence in local inland forests. To bridge this research gap, a preliminary camera trap survey was conducted in the Crocker Range Biosphere Reserve (CRBR), an area known to host both pheasant species, with the intention to monitor their patterns of local forest use. It was hypothesized that both species would exhibit higher activity levels during the day, and vice versa at night, as suggested by Phillipps and Phillipps (2014) and Clink et al. (2021). Moreover, it was anticipated that the smaller crested partridge (25.0-26.0 cm) would decrease its activity during the peak activity hours of the larger great argus (60.0-120.0 cm), as indicated by Chen et al. (2019) and Lim et al. (2023). The present findings would offer valuable insights into the feasibility of using camera traps for long-term monitoring of Phasianidae species within Sabah.

## MATERIALS AND METHODS

Crocker Range Biosphere Reserve comprises a totally protected area of about 350,584 ha, while under the management of Sabah Parks to promote a harmonious relationship between humans and biosphere through various conservation efforts (Sabah Parks, 2025). To enhance accessibility and enable efficient management, 11 substations have been strategically established throughout this reserve. This study was commenced at the Inobong Substation, which was situated on the northwestern boundary of CRBR and within the Penampang District. The site is characterized by steep, undulating terrain primarily covered with hill dipterocarp forest, with elevations ranging from 350.0 m to 800.0 m above sea level. Moreover, the site experiences an average annual temperature of around 26.0oC and annual rainfall of about 2251.0 mm. This substation is majorly used by the public for recreational activities, with vehicle access limited to the base camp area. The adjacent forested area can be accessed via three main trails: Bansadon Trail, Waterfall trail, and Salt Trail. In accordance with the Sabah Parks regulations, 10 sampling points were systematically installed along designated local vehicle roads and hiking trails, each spaced at least 200.0 m apart and 5.0 m from the edges of these pathways (Figure 1).

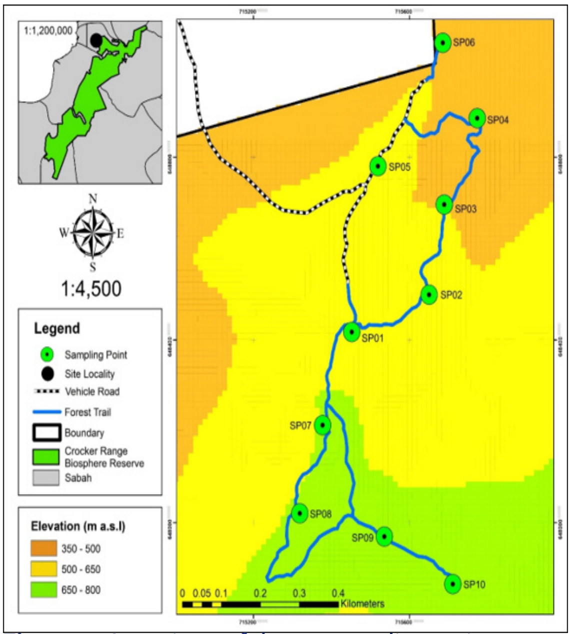


**Figure 1:** Locations of the 10 sampling points at the Inobong Substation within the Crocker Range

All sampling points were surveyed over a period of roughly 9 to 10 weeks, from January 17th to April 25th, 2024. At each point, a Ka Shi H7 camera trap with passive infrared motion sensors (Zhen Shi Jie Ke Ji Co., Ltd.) was mounted onto a vertical tree at a height of 0.5 to 1.5 m above ground level, directed toward the forest floor at a distance of 2.0 to 5.0 m. The devices were set to capture three consecutive photos per trigger, with a 60-sec delay before reactivation (Lim et al., 2024), primarily to document the activity patterns of the great argus and crested partridge at these sampling points (Figure 2). To maintain functionality across the sampling period, the camera traps were serviced every three weeks, by clearing any visual obstructions and replacing both memory cards and batteries.

Non-parametric tests were applied for data analysis in this research, as the datasets were determined to follow a non-normal distribution (Shapiro-Wilk test: $p < 0.05$), with the analysis commenced in RStudio ver. 2024.12.1+562 (R Core Team, 2025) at a 95.0 % confidence interval ($p = 0.05$). The Mann-Whitney test was utilized to assess variations in detection frequencies and group sizes between the two pheasant species. Furthermore, the diel activity patterns of the two pheasant species were depicted through kernel density plots, and their similarity was examined using the analysis of overlapping, which was measured by the coefficient of overlapping (Δ) (Chen et al., 2018). This metric quantifies the degree of similarity between the diel activity pattern of two species, with a value of 0 denoting no overlap and 1 indicating complete overlap. Formula $\Delta 1$ was used to estimate this coefficient, since both species had sample sizes below 50 (Ridout and Linkie, 2009). Consequently, the resulting coefficient was classified as very high ($\Delta > 0.75$), high ($0.50 < \Delta < 0.75$), low ($0.25 < \Delta < 0.50$), or very low ($\Delta < 0.25$).

**Figure 2:** Images of the great argus (left) and crested partridge (right) detected at sampling points in the Inobong Substation of the Crocker Range Biosphere Reserve, Sabah

## RESULT AND DISCUSSION

Over 675 camera trap, the great argus was recorded at the sampling points on eight occasions, while the crested partridge appeared six times. Two types of activity were observed in both species, which were passing through and foraging near the deployed camera traps. In this study, "passing through" referred to these two species moving across the area without engaging in any other activity, whereas "foraging" described their search for food such as fruits, seeds, flowers, leaf buds, and invertebrates on the forest floor, within the field of view of the nearest camera trap during an independent sighting event (Phillipps and Phillipps, 2014; Birdlife International, 2020). Other activities commonly exhibited by these species, such as roosting, courtship ritual, and both intraspecific and interspecific interactions, were not observed at the sampling points. These results indicate that these areas primarily serve as navigation and foraging areas, thereby highlighting their ecological importance to both species within the study site (Wielstra et al., 2011; Ramadhanti et al., 2025).

The great argus was primarily found passing through the sampling points (n = 5 or 62.3%), with foraging behaviour documented in three instances (37.7 %). In contrast, the crested partridge was mostly detected foraging in these areas (n = 5 or 83.3%), while only one detection (16.7 %) indicated it passing through these areas. Both species are known to depend heavily on natural forests for movement, foraging, and shelter, but threatened by illegal hunting and habitat loss due to logging, deforestation, and land cover change (Birdlife International, 2020 and 2021). As a result, these pheasant species tend to avoid areas with degraded environments and high human activity levels, thereby rendering them less likely to be detected in such areas compared to natural forests (Samejima et al., 2012; Jati et al., 2018). Ultimately, the infrequent detections of these species across the sampling period may underscore that the established sampling points showed unfavourable conditions for regular use and heightened risks of human-related predation (Hon and Shibata, 2013; Lim et al., 2024). Nevertheless, the behavioural differences observed between these pheasant species suggest that the crested partridge is better adapted to the environmental conditions of these areas for food acquisition compared to the great argus, despite their similar dietary preferences (Wielstra et al., 2011; Samejima et

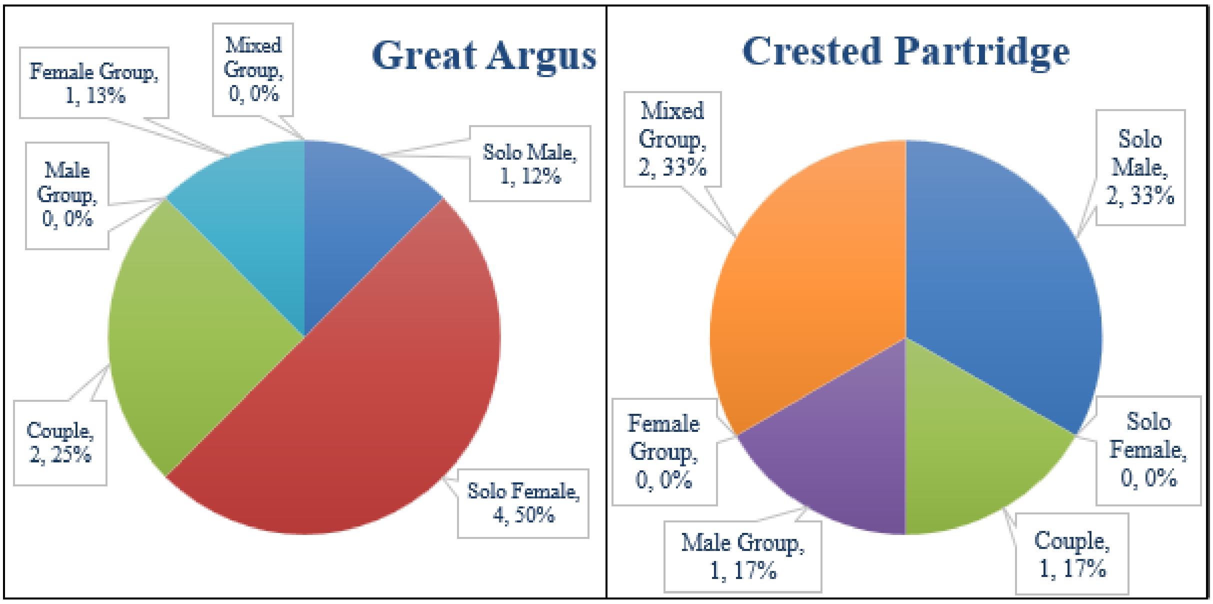


**Figure 3:** Group compositions of the great argus (left) and crested partridge (right)

al., 2012; Lim et al., 2023).

Both species were recorded either individually or in groups of varying size and sex compositions (Figure 3). The great argus was most regularly detected as solitary female (n = 4 or 50.0 %), followed by pairs (n = 2 or 25.0 %), and once each as a solitary male (12.5 %) and a female pair (12.5 %). In contrast, the crested partridge was most frequently observed as solitary males and in mixed-sex groups (n = 2 or 33.3 % each), followed by pairs and all-male groups, each detected only once (16.7 % each). Although no specific studies have examined the group composition of these two species in Borneo, it has been noted that the great argus generally moves alone or in pairs, while the crested partridge typically travels alone or in groups of different sizes and sex compositions (Phillipps and Phillipps, 2014). Consequently, the crested partridge was validated to have a larger average group size (2.833 ± 0.703) than the great argus (1.375 ± 0.183), but this difference was not statistically significant (Z = 1.539, p = 0.124).

The kernel density plots revealed that the diel activity pattern of crested cartridge across the 10 sampling points highly resembled that of the great argus (Δ1 = 0.5787) (Figure 4). This similarity was caused by the fact that both species being inactive at night and active during twilight hours and daytime at these points throughout the sampling period. Bornean pheasants are typically diurnal, foraging during the day and roosting at night (Phillipps and Phillipps, 2014). While prior research in East Kalimantan (Borneo) reported that the great argus might vocalize at night, its activity on the forest floor has been reported to occur from dawn to dusk (Clink et al., 2021; Ramadhanti et al., 2025), thereby supporting the results of this research. Conversely, no past studies have specifically examined the diel activity pattern of crested partridge, which limits the available information to that provided by Phillipps and Phillipps (2014).

The great argus was primarily active during the day (n = 7 or 87.5 %), with only one detection recorded during twilight hours (12.5 %). In addition, its activity peaked in the late morning, between 10.00 a.m. and 12.00 p.m., which aligned with the results of Ramadhanti et al. (2025), where the peak activity of this species was observed primarily during the morning hours, from 7.00 a.m. to 12.00 p.m. In contrast, the crested partridge was observed equally often during both daytime and twilight hours (n = 3 or 50.0% each), with reduced activity during peak activity hours of the great argus and increased activity at other daytime and twilight hours. Given their similar omnivorous diets and habitat preferences, the given two

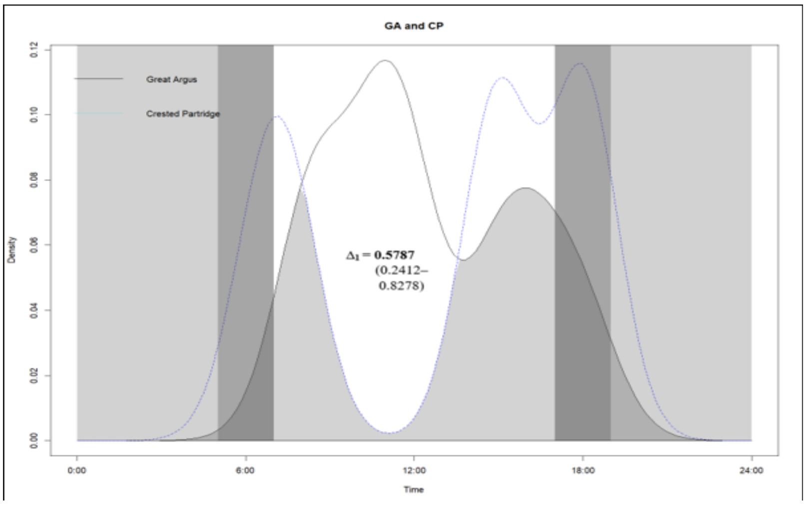


**Figure 4:** Kernel density plots illustrating the diel activity patterns of the crested partridge and great argus, focusing on the coefficient of overlapping (Δ1) and confidence interval (shown in parentheses)

species likely to compete for food, shelter, and movement space on the forest floor (Ridout and Linkie, 2009; Wielstra et al., 2011; Phillipps and Phillipps, 2014). This distinct difference in peak activity hours potentially reflects an avoidance strategy by the smaller crested partridge in response to the larger great argus. Interspecific competition often drives smaller species to adjust their diel activity patterns to avoid direct interactions with larger species in shared habitat areas, triggered by a sense of intimidation (Chen et al., 2019; Lim et al., 2023). As a result, despite the overall high similarity in their diel activity patterns, these two pehasant species showed different peak activity hours, thereby emphasizing a subtle form of temporal niche partitioning that would facilitate their coexistence and optimize resource utilization at the sampling areas within the study site (Ridout and Linkie, 2009).

In summary, the present findings indicate that the study site provides suitable environmental conditions to support the livelihoods of both the vulnerable crested partridge and great argus (Birdlife International, 2020 and 2021), with both species visiting local forest floor areas close to reserve boundaries and human pathways for foraging and navigation. Moreover, their activity patterns in these areas are likely dictated not only by local environmental conditions, but also by their interactions with humans, with each other, and with other wildlife species inhabiting the study site (Jati et al., 2018; Chen et al., 2019; Lim et al., 2023). Nevertheless, although no signs of illegal hunting were observed during the sampling period, the close proximity of these areas to human pathways and reserve boundaries may render them susceptible to encroachment by adjacent communities, and local hiking trails are utilized by tourists for recreational activities (Kurz et al., 2023; Kobayashi et al., 2024). Consequently, the use of these sampling areas may increase the likelihood of close encounters between these two species and humans, thereby heightening their risk of human-related predation and potentially causing long-term negative alterations to their local activity patterne (Hon & Shibata, 2013; Kobayashi et al., 2024). Since this research did not evaluate the impacts of anthropgenic disturbance on the activity patterns of these two pheasant species, the type and degree of such disturbances remain unclear, thereby underscoring the neccessity for further research to address these issues at the study site in future. Expanding local research efforts would not only provide a more comprehensive understanding of their local activity patterns, but also facilitate monitoing of the spatio-temporal variability in their behaviour, abundance, and distribution across the study site (Clinks et al., 2021; Kurz et al., 2023; Lim et al., 2024; Ramadhanti et al., 2025).

Moreover, the relatively large body sizes of both the great argus and crested partridge render them easily detectable by camera traps, thereby supporting the use of these devices for long-term monitoring of these species at the study site and other inland forests of Sabah, as well as aligning with prior research conducted in Borneo (e.g. Samejima et al., 2012; Jati et al., 2018; Ramadhanti et al., 2025). However, the infrequent sightings and low activity diversity recorded for these two pheasant species at the 10 sampling points could be resulted from the experimental design of this study. Firstly, this research was confined to forest areas near human pathways and the base camp within the substation, which were more degraded and easily accessible to humans, and thus likely used less frequently by the two pheasant species compared to more remote forest areas (Hon and Shibata, 2023; Lim et al., 2024; Ramadhanti et al., 2025). Furthermore, while the applied camera placement was intended to enhance detection rates, deploying only one camera trap per sampling point limited the field of view and potentially reduced the probability of detecting these two species (Samejima et al., 2012; Kurz et al., 2023). The relatively short sampling period (less than 100 days per point) could also have contributed to the low recorded detection frequencies in this study, as previous research typically surveyed each point for over 100 days to achieve higher detection frequencies (e.g., Samejima et al., 2012; Jati et al., 2018; Ramadhanti et al., 2025). In short, these methodological limitations could help elucidate the low detection frequencies of these two threatened species throughout the sampling period, although further research is necessitated to validate this matter in the future.

## CONCLUSION

Evidence from the preliminary camera trap survey highlights that the recorded activity patterns for the great argus and crested partridge in this research are consistent with results from prior studies conducted in Borneo. This supports the feasibility of utilizing camera traps for long-term monitoring of these two threatened, relatively large-sized pheasant species within the inland forests of Sabah. Additionally, the observed subtle temporal niche partitioning emphasizes that the smaller crested partridge is capable of coexisting with the larger great argus on the shared forest floor areas within the Inobong Substation of CRBR, which is potentially driven by interspecific competition for food, shelter, and movement space. Nonetheless, it is essential that future research addresses the limitations of this study, by examining the impact of anthropogenic disturbance on these two species, deploying at least two camera traps for each sampling point, expanding coverage to comprise more remote forest areas within CRBR, and extending the sampling duration at each point. Consequently, these improvements would yield results that offer a more holistic understanding of their ecology and support the monitoring of their behaviour, abundance, and distribution across the entire reserve.

## CONFLICT OF INTEREST

There was no conflict of interest.

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