

# Altitudinal differences in habitat use by Siamese fireback *Lophura diardi* and silver pheasant *Lophura nycthemera* in Khao Yai National Park, Thailand

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**Abstract** Over the last past 25 years, Siamese fireback appear to have undergone a range extension, expanding into higher elevation habitat in Khao Yai National Park, Thailand, where previously silver pheasant predominated. To investigate this expansion, thought to have been triggered by climate change and subsequent changes in forest microhabitat conditions, a long-term project was initiated. The aim of this study was to investigate the altitudinal use of habitat of the two *Lophura* species. We used colour bands (rings) and radio-collars to study the birds. In the areas where pheasants were observed, we collected data on elevation and slope. The results reveal a distinct difference in habitat use and elevation between the two species, although Siamese fireback were observed at higher elevation, they prefer level areas while silver pheasant were found mainly on slopes. The results indicate differences in suitable habitat for each of the two sympatric species which appeared to be separated along an elevational gradient of approximately 15 degrees with a small overlapping area where both species cohabit in close contact. However, all nests of both Siamese fireback and silver pheasant were found on steep slopes (above 15 degrees). This is interpreted as a strategy to minimize predator access to nests and to permit easy flight to avoid predation.

**Keywords** Habitat use, radio-telemetry, Siamese fireback, silver pheasant, sympatric, Thailand

## Introduction

Observations conducted in Khao Yai National Park, central Thailand, during the past twenty years have reported a range expansion of Siamese fireback *Lophura diardi* into higher elevations up to 800 m, where previously silver pheasant *Lophura nycthemera* was more typically found (Round & Gale, 2008). The explanation for this expansion (Round & Gale, 2008) is climate change observed during the past 100 years, whereby the average temperature has increased about 0.6° C (Houghton et al., 2001). Round & Gale (2008) also speculated that these increased temperatures, and consequent changes in evapotranspiration, have led to drier microhabitats upslope, resulting in an increase in the numbers of Siamese fireback relative to the resident silver pheasant. This is based primarily on observations elsewhere that suggest that tropical forest birds are particularly sensitive to micro-climatic gradients (Karr & Freemark, 1983). In cloud forest of Costa Rica, Pounds et al. (1999) observed rapid changes in species composition. The colonization of montane

habitats by non-montane species was the consequence of drier habitat created by a decrease in the frequency of mist.

Although on a large scale the genus *Lophura* appears sympatric in a few locations, it is always ecologically separated by topographical barriers such as in Sumatra where *L. ignita* is a lowland species replaced at higher elevations by *L. hoogerwerfi*, in the north of the island, or *L. inornata*, in the southern part (BirdLife International, 2001), or habitat differences, as in West Malaysia where *L. ignita* inhabit wet riverine forest while *L. erythrophthalma* prefer drier slopes (Davison, 1981). As for other *Lophura* species, silver pheasant and Siamese fireback appear sympatric in their wide range but segregated. In Laos, they are naturally segregated by different elevations with silver pheasant usually predominating at 500 m or above while Siamese fireback are found in the lowlands (Thewlis et al., 1998). A similar segregation pattern has been so far observed in Thailand (Lekagul & Round, 1991) with the exception of Khao Yai National Park (Round & Gale, 2008). Silver pheasant and Siamese

fireback are found sympatrically over much of their SE range (Dickinson, 2003). In their range in Thailand these two species are largely segregated by elevation and consequently moisture. Silver pheasant are montane and submontane in distribution, occurring at elevations of 700 m and above, while Siamese fireback is a characteristic lowland species, inhabiting forest in plains and foothills to a maximum elevation of 700 m (Lekagul & Round, 1991; Robson, 2000). In Vietnam, where the situation is more complicated and possible encounters between two *Lophura* species might have occurred, hybridization was observed, resulting in *L. imperialis* (Hennache et al., 2003), once considered a critically endangered species (McGowan & Garson, 1995).

In this paper we present the results of an ongoing study of pheasant topographical use of habitats to define characteristics and differences in micro-habitat use between syntopic Siamese fireback and silver pheasant in Khao Yai National Park. We hypothesize that topography is influencing habitat use by pheasants, for which silver pheasant, a montane species, will mostly occupy slopes with drier soils, while Siamese fireback, a lowland species, will mostly occupy flat patches with higher soil moisture.

We assess the implication of overlap between the two species in order to evaluate the possibility of inter-species inbreeding as a result of this "forced" sympatry.

## Study area and methods

The study began in January 2007 at the Mo Singto Long-term Biodiversity Research Plot, Khao Yai National Park (for details on the plot see Brockelman et al., 2002), Thailand (2,168 km<sup>2</sup>; 101°22' E, 14°26' N; ~ 130 km NE of Bangkok), in hilly terrain 730 - 890 m above sea level. Khao Yai is a seasonally wet, evergreen forest (Kerby et al., 2000; Kitamura et al., 2004). This site has a distinct dry (November - April) and wet (May - October) season with an average precipitation of 2697 mm (range 2976 to 2297 mm) (Savini et al., 2008). Average daily temperature varies between 18.7° C and 28.3° C annually and mean humidity ranges from 64.6% during the dry season to 77.1% during the wet season (Savini et al., 2008).

Starting in January 2006 pheasants were caught using mist-nets and snare traps made

from bamboo and soft polyester string. Leg-snare traps were also set on the ground using string tensioned with a ~1.5 m piece of bamboo. Mist nets were set on the ground to a height of approximately 3 m. We used 15 cm mesh, 3 shelf mist nets 12 metres in length and 2.75 metres in height. All pheasants caught were ringed with a size 11A Thai Royal Forest Department (RFD) metal ring and colour-ringed with two-colour combinations on the left leg and one colour-ring and one metal ring on the right leg, to facilitate individual identification in the field. Each bird was weighed, measured and examined for stage of moult. From February 2007 - 2008 five birds were fitted with 15 g necklace radio collars (model RI-2B, Holohil Systems Ltd) with a battery life of 24 months. The RI-2B is designed as a necklace-mounted transmitter. The transmitter rests on the bird's breast while the antenna loops around the neck and emerges behind the head. The collar is made of flexible elastic attached to the transmitter at two points.

Pheasants were located by systematically walking the study site to locate colour-ringed birds and by radio-telemetry. The radio-telemetry was conducted on a daily basis with each pheasant located at two-hour intervals. After locating, each pheasant was followed for fifteen minutes during which observations on behaviour, diet, travel route and topographic position were collected. After 15 minutes the pheasant, and its group, was left to reduce any impact on behaviour and another collared individual was located. The first pheasant was again relocated after two hours.

To investigate potential differences in their use of topography and elevation, location data were compared among groups of Siamese fireback and between the two pheasant species using non-parametric procedures (Kruskal-Wallis H-test and Mann-Whitney U-test respectively). The analysis was conducted using SPSS version 16.0.

## Results

Four groups of Siamese fireback and one group of silver pheasant were observed during the sixteen-month study. The topography of the habitats used by all four groups of Siamese fireback (SMF) did not differ significantly from that available across the study site (Kruskal-Wallis H-test,  $\chi^2 = 4.8$ ,  $n_{SMF\ group1} = 107$ ,  $n_{SMF\ group2} = 118$ ,  $n_{SMF\ group3} = 120$ ,  $n_{SMF\ group4} = 114$ ,  $P = 0.185$ ). There was however a significant difference in the gradient of habitats used by

Siamese fireback compared to the gradient of habitats used by silver pheasant (SPH) (Mann-Whitney *U*-test,  $z = -9.3$ ,  $n_{SMF} = 459$ ,  $n_{SPH} = 50$ ,  $P < 0.0001$ ) with silver pheasant found mainly on slopes and Siamese fireback found mostly on flat areas (FIG. 1).

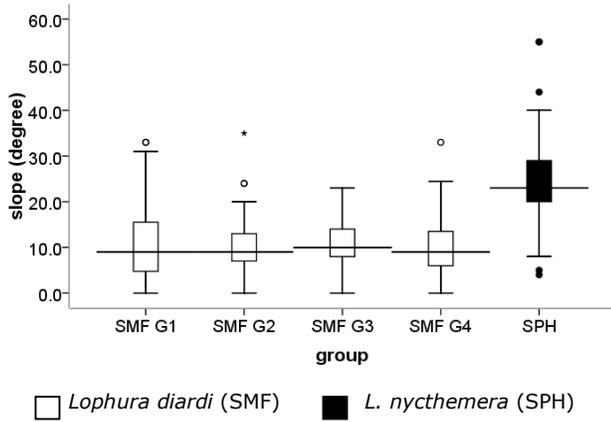


FIG. 1 The slope comparison among Siamese fireback four groups and with silver pheasant.

The elevation use between the four Siamese fireback groups was significantly different (Kruskal-Wallis *H*-test,  $\chi^2 = 250.4$ ,  $n_{SMF\ group1} = 114$ ,  $n_{SMF\ group2} = 118$ ,  $n_{SMF\ group3} = 143$ ,  $n_{SMF\ group4} = 115$ ,  $P < 0.0001$ ). Moreover, there was also a significant difference between the two *Lophura* species (Kruskal-Wallis *H*-test,  $\chi^2 = 262.2$ ,  $n_{SMF\ group1} = 114$ ,  $n_{SMF\ group2} = 118$ ,  $n_{SMF\ group3} = 143$ ,  $n_{SMF\ group4} = 115$ ,  $n_{SPH} = 79$ ,  $P < 0.0001$ ). Silver pheasant was found at higher elevations only when compared to Siamese fireback group 1, but used lower elevations when compared with Siamese fireback group 2, 3 and 4 (FIG. 2).

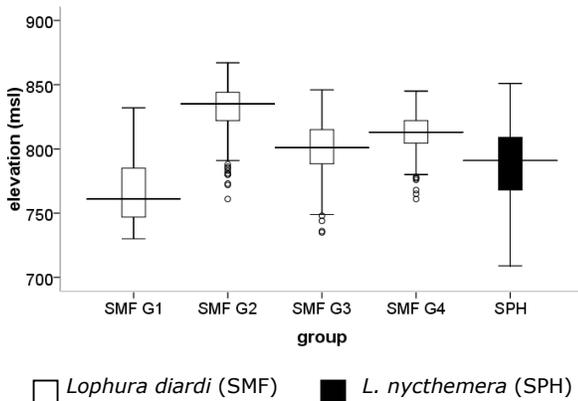


FIG. 2 Elevation comparison among Siamese fireback four groups and with Silver Pheasant.

Locating pheasant nests in the field was difficult due to the highly cryptic behaviour of the

females. In total, nine nests, one silver pheasant and eight Siamese fireback were located (TABLE 1). All nests from Siamese fireback were on terrain with a gradient higher than 15 degrees (TABLE 1).

TABLE 1 The topography of nest site of two pheasant species.

Species	Slope (degree)
Siamese fireback	35
Siamese fireback	18
Siamese fireback	27
Siamese fireback	25
Siamese fireback	24
Siamese fireback	26
Siamese fireback	19
Siamese fireback	18
silver pheasant	55

### Discussion

The results confirm our predictions, that silver pheasant mostly occupy slopes, while Siamese fireback mostly occupy flat areas, although soil types between slope and flat areas will be required to test the difference in micro-habitat. The topographical separation between Siamese fireback and silver pheasant occurs at roughly 15 degrees, physically separating the two species. An exception to this pattern was observed where Siamese fireback also selected nesting areas located on steep slopes. However, our prediction that silver pheasant will generally use areas at higher elevation than Siamese fireback is rejected. Overall our hypothesis, for which topography influences habitat selection and use by each of the two pheasant species, can be accepted.

The topography of the Mo Singto Long Term Biodiversity Research Plot is an undulating plateau ranging in elevation between 600 to 890 m, with over 80% of the area lying above 750 m which is the elevation where mostly silver pheasant were previously found (Round & Gale, 2008). In Thailand, Siamese fireback is the species that is characteristic of lowland semi-evergreen forest, occupying drier plains and foothills. In contrast silver pheasant, the montane species, occupy uphill evergreen forest, where the structure is varied with both drier ridges and moister slopes (Round, 1988). Although they have been moving to higher elevations, Siamese fireback seem to use areas with the same topography that they use in the plains. Where flat areas are located on ridge tops and along streams the new niche is the

most similar to the one found in the lowland habitat. Elevation itself did not appear to be the driving force for their range limitation as elevation did not correlate with topography in our study site.

Although topographical variation in our study site might be related to the different vegetation, with consequent difference in food supplies, both pheasant species seem to have similar diets and foraging behaviour, consuming a wide range of invertebrates and plant matter (Johnsgard, 1999). We have never observed direct feeding competition between these two species but can assume that topographical variation does not cause food limitation as food supplies do not appear to be delimiting the use of specific areas within the study site.

Nest locations, on steep slopes for both species, can be interpreted as a strategy to make the nests less accessible to predators and facilitate flushing down slope in steep terrain to escape predators as is common among the Galliformes (Lima, 1993). However, such behaviour has yet to be quantified at the site because of the small sample of nests; additional research focusing on this issue is on-going at the site.

Syntopy in avian congeners has been studied with two flycatcher species *Elaenia flavogaster* and *E. martinica* in the Windward Islands and Trinidad (Crowell, 1968). Although the diets between these two closely related species were similar in food composition, their feeding behaviour and habitat preference appeared to be different. In contrast, two sympatric gibbon species, *Hylobates agilis* and *H. (Symphalangus) syndactylus* in the Sumatran rain forest showed similar use of forest structure and composition of their habitat, but their dietary overlap was reduced with *H. agilis* having a high fruit component of the diet while *H. syndactylus* showed a larger leaf component (O'Brien et al., 2004). On our study site, two gibbon species, *H. lar* and *H. pileatus*, show a similar use of habitat and a similar diet resulting in mixed-species groups that appear to be hybrids.

Our results show that there is a topographical threshold in the use of habitat that might reduce the risk of interbreeding between the two pheasants observed in captive birds (Ghigi, 1968) and between other wild ranging species of the genus *Lophura* such as silver pheasant and kalij pheasant (*L. leucomelana*) in Yunnan and Burma (Johnsgard, 1999) and between Edwards's (*L. edwardsi edwardsi*) or

Vietnamese (*L. edwardsi imperialis*) and silver pheasant resulting in the imperial pheasant, long considered a separate species (Johnsgard, 1999; Robson, 2000; Hennache et al., 2003). However, a small area of overlap, around the 15 degree threshold, has been observed where both species sporadically occur. Second, mixed-species groups between these two species have been observed in the area. This social formation has been explained as the consequence of a difference in the mating behaviours of the males in each species (Savini & Sukumal, 2009).

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## Biographical sketches

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