

Spizaetus hawk-eagles as predators of arboreal colobines

S. D. Fam · V. Nijman

Received: 4 June 2010 / Accepted: 31 January 2011 / Published online: 22 February 2011
© Japan Monkey Centre and Springer 2011

Abstract The predation pressure put on primates by diurnal birds of prey differs greatly between continents. Africa and South America have specialist raptors (e.g. crowned hawk-eagle *Stephanoaetus coronatus* and harpy eagle *Harpia harpyja*) whereas in Asia the only such specialist's (Philippine eagle *Pithecophaga jefferyi*) distribution is largely allopatric with primates. The almost universal absence of polyspecific groups in Asia (common in Africa and South America) may indicate reduced predation pressure. As such there is almost no information on predation pressures on primates in Asia by raptors. Here we report successful predation of a juvenile banded langur *Presbytis femoralis* (~2 kg) by a changeable hawk-eagle *Spizaetus cirrhatus*. The troop that was attacked displayed no signs of being alarmed, and no calls were made before the event. We argue that in insular Southeast Asia, especially, large *Spizaetus* hawk-eagles (~2 kg) are significant predators of arboreal colobines. Using data on the relative size of sympatric *Spizaetus* hawk-eagles and colobines we make predictions on where geographically we can expect the highest

predation pressure (Thai–Malay Peninsula) and which colobines are least (*Nasalis larvatus*, *Trachypithecus auratus*, *P. thomasi*) and most (*P. femoralis*, *T. cristatus*) affected.

Keywords Changeable hawk-eagle · Langurs · *Nisaetus* · *Presbytis* · Predation · Socioecology

Introduction

Predation is regarded as a major selection pressure on various aspects of primate (socio)ecology and evolution (van Schaik 1983; Isbell 1994; Sterck et al. 1997). In forested areas an arboreal lifestyle may release the pressure of terrestrial predators (van Schaik and van Hooff 1996; Shultz et al. 2004) but in various parts of the world during the day-time specialist raptors, for example the crowned hawk-eagle *Stephanoaetus coronatus* (Africa) and the harpy eagle *Harpia harpyja* (Neotropics) pose a significant threat (Hart 2007; Miller and Treves 2007), both to terrestrial and arboreal primates (Shultz et al. 2004). In Madagascar numerous predation events have been documented on diurnal lemurs, mainly by Madagascar harrier hawk *Polyboroides radiatus* and Henst's goshawk *Accipiter henstii* (Karpanty and Goodman 1999; Karpanty and Wright 2006), shaping lemur socio-ecology (Karpanty 2006). Despite Asia having ~35 species of large raptor living sympatrically with ~45 diurnal primates, and dedicated research on Asian primates dating back at least 50 years, we only have approximately 25 documented cases of successful predation by raptors on diurnal primates (Supplementary Table 1). Overall, there does not seem to be a specialised primate-targeting raptor in Asia. The Philippine eagle *Pithecophaga jefferyi* (note the generic name “monkey-eater”) has been postulated as a significant predator of long-tailed macaques

Electronic supplementary material The online version of this article (doi:10.1007/s10329-011-0240-z) contains supplementary material, which is available to authorized users.

S. D. Fam · V. Nijman (✉)
Department of Anthropology and Geography, Oxford Brookes
University, Gypsy Lane, Oxford OX3 0BP, UK
e-mail: vnijman@brookes.ac.uk

S. D. Fam
Southeast Asian Biodiversity Society, Singapore, 50 Block 504,
Choa Chu Kang Street 51, #01-173, Singapore 680504,
Singapore

V. Nijman
Zoological Museum Amsterdam, PO Box 94766,
1090 GT Amsterdam, The Netherlands

Macaca fascicularis, and indeed is known to prey on them (reviewed in Collar et al. 2001). However, detailed nest observations on Mindanao indicate that ~4% of the identifiable prey items were long-tailed macaques (3/48; Gonzales 1968; 5/158 Kennedy 1985; 0/17 Ibañez et al. 2003) with the main prey (~60% of identifiable items) being flying lemurs *Cynocephalus volans*.

The almost universal absence of polyspecific groups in Asia (common in Africa, Madagascar, and South America) may be indicative of reduced predation pressure. On the basis of the general prey-items recorded (Ferguson-Lees and Christie 2001; see below), accounts of attempts at predation and actual predation (Hart 2007; Supplementary Table 1), handling and working with Asian eagles (V. Nijman), and the size of the eagles relative to sympatric primates, we consider *Spizaetus* hawk-eagles and *Aquila* eagles the most likely candidates as significant predators on primates in Asia. *Aquila* eagles live sympatrically with primates mostly in South Asia and to a smaller extent East and mainland Southeast Asia (some *Aquila* eagles only winter there, breeding at more northern latitudes). *Spizaetus* hawk-eagles usually live sympatrically with primates year-round throughout Asia. Although *Aquila* eagles are larger than *Spizaetus* hawk-eagles (maximum recorded weights of females between ~2.2 and 6.4 kg for *Aquila* compared with ~0.6–3.5 kg for *Spizaetus*), clear differences in habitat use (open woodland vs. forest), hunting techniques (hunting in flight taking prey from the ground versus still hunting in forest taking prey from all levels or hunting above the canopy), and morphology (with *Spizaetus* hawk-eagles having lower aspect ratios, which increase manoeuvrability) virtually eliminate *Aquila* eagles as significant predators of forest primates. Note that, possibly because of its large wingspan, the Indian black eagle *Ictinaetus malayensis* (~1.6 kg) has been postulated as a predator of primates (MacKinnon 1974: 37; Ali 1986; Matsuda et al. 2008; the entry in Miller and Treves 2007: 527 should have been to the African black eagle *A. verreauxii*), however it is clearly a specialised feeder on the contents of bird's nests (Nijman 2004a; Ferguson-Lees and Christie 2001; but see Gunawardena 2006) and it is unlikely to be a significant predator of primates.

Our objective is to provide evidence that suggest that *Spizaetus* hawk-eagles are more significant predators of forest primates, and especially arboreal colobines, than currently assumed. In addition we give a detailed account of successful predation of a changeable hawk-eagle on a banded langur *Presbytis femoralis*.

Methods

We restrict the analysis to that part of insular Southeast Asia where *Spizaetus* hawk-eagles and colobines live

sympatrically, i.e. the Thai–Malay Peninsula, Sumatra, Borneo, Java, Bali, and Lombok. In this region 15 species of arboreal colobines (*Trachypithecus*, *Presbytis*, *Nasalis*, and *Simias*) and six hawk-eagle species can be found, with up to five colobines and three hawk-eagles living sympatrically.

Predation event

We document a single predation event that was witnessed at Panti Forest Reserve near the southeastern coast of the Thai–Malay Peninsula (1°50'N 103°54'E). The ~100 km² area is covered by lowland and hill dipterocarp and peat swamp forests (Birdlife International 2009). Part of it is designated as a bird sanctuary and is popular among bird watchers from the surrounding regions. Apart from the nocturnal greater slow loris *Nycticebus coucang*, five diurnal primates species are present (long-tailed macaque, pig-tailed macaque *M. nemestrina*, banded langur, dusky langur *T. obscurus*, and lar gibbon *Hylobates lar*), and terrestrial predators such as tiger *Panthera tigris* and leopard *P. pardus*. From photographs (e.g. Supplementary Figures 1 and 2) we estimate the body length and tail length of the predated juvenile by comparing it with the eagle, using published measurements of changeable hawk-eagles (wing > 380 mm, tail > 240 mm, tarsus > 100 mm: Ferguson-Lees and Christie 2001); using these lengths its body mass is estimated by comparisons with body measurements of white-thighed langur *P. siamensis* ($n = 22$) and mitred langur *P. melalophos* ($n = 54$) (Aimi and Bakar 1992).

Predicting potential predation pressure

In exploring potential predation pressure between different species-pairs we focus on female hawk-eagles (the larger sex) and female colobines (the smaller sex). Although *Spizaetus* hawk-eagles may prefer to predate on juvenile or infant colobines (9 of the 12 cases of primates being predated by *Spizaetus* hawk-eagles involved juveniles: Iida 1999; Nijman et al. 2000; Sun et al. 2009; this study) data on the weights of these individuals are largely unavailable. Under the assumption that large-bodied colobine species will have larger young, that larger females are, potentially, better at protecting their offspring against arboreal predators, and that smaller females are more likely to be prey than larger ones, we here use female colobine size as a proxy for vulnerability to raptor predation.

There is a strong positive relationship between wing length and body mass in *Spizaetus* hawk-eagles (Pearson's $r = 0.958$, $n = 10$, $P < 0.001$) and we use this to calculate female body mass based on female wing length (data from Ferguson-Lees and Christie 2001 and Wells 1999).

Weights of adult females range from ~ 0.6 kg in *S. nanus* to ~ 1.8 and ~ 2.0 kg for Malaysian mountain hawk-eagle *S. nipalensis* and Flores hawk-eagle *S. flores*, respectively. Female colobines range in body mass from ~ 5.6 kg for the white-fronted langur *P. frontata* to ~ 7.5 and 8.2 kg for Thomas' langur *P. thomasi* and *P. siamensis*, respectively, with the female proboscis monkey *Nasalis larvatus* in excess of 9.0 kg (data from Rowe 1996; Rowe and Myers 2010). We expect predation pressure to be highest in those areas where relatively large *Spizaetus* hawk-eagles live sympatrically with one or more relatively small colobines. Relatively large colobines that live sympatrically with relatively small *Spizaetus* hawk-eagles are hypothesised to be least affected by these arboreal predators.

Results

Predation event

On 7 June 2009 at 10:00 h, a pale-morph changeable hawk-eagle was spotted at a distance of ~ 50 m on the main trail that leads through the bird sanctuary. A kill had been made, and the prey still being alive, because its tail was flicking. As the hawk-eagle was slowly approached it flew off with its prey only to land in a tree nearby. It then became clear the prey was a juvenile banded langur *Presbytis femoralis* (see Supplementary Figures 1 and 2). A troop of banded langurs were observing the eagle at a distance of ~ 50 m. The event was observed for a period of 15 min, and during this period the langurs did not show any sign of being disturbed, i.e. no calls were heard and no sudden movements (mobbing, fleeing, being agitated) were observed (Supplementary Figure 3). No other groups of langurs were observed in the area.

We estimate the infant's body length and tail length at 25 and 50 cm, respectively. Its body mass is estimated at 1.9 kg.

Spizaetus hawk-eagles as potential predators of colobines

The information available on the three best-studied species shows that *Spizaetus* hawk-eagles predate on a large range of prey, including large ground birds, terrestrial and arboreal mammals, including primates, weighing in excess of 2–3 kg (Table 1). The weighted average mass of these large prey items is 1.9 ± 1.0 kg ($n = 109$) with the 10% most heavy prey items weighing over 2.5 kg. While these relatively large prey items in some studies make up a small proportion of all prey taken (e.g. 6% in Javan hawk-eagles in Indonesia (Prawiradilaga 2006; Nijman et al. 2000), 7% in mountain hawk-eagles in Japan (Kaneda 2009)) in others

it comprises more than half (53% in mountain hawk-eagles in Taiwan (Sun et al. 2009)).

There is a significant positive relationship between *Spizaetus*' female body mass and maximum recorded prey mass (Pearson's $r = 0.903$, $n = 6$ *Spizaetus* species, $P = 0.005$), suggesting that all but the two smallest *Spizaetus* species are capable of catching prey in excess of 3 kg. On the basis of these data we infer that *Spizaetus* hawk-eagles are fully capable of preying on infants and juveniles of most colobine species, and, especially, on the smaller adult individuals.

Colobines that have a relatively small body weight (< 5.9 kg) and that live sympatrically with relatively heavy hawk-eagles (> 1.7 kg) are expected to be at high risk. These are the banded langur on the Thai–Malay Peninsula (sympatrically with changeable hawk-eagle and mountain hawk-eagle) and Sumatra (changeable hawk-eagle), the silvered langur *T. cristatus* on Sumatra, Thai–Malay Peninsula and Borneo (changeable hawk-eagle), the mitred langur on Sumatra (changeable hawk-eagle), and the white-fronted langur on Borneo (changeable hawk-eagle). Relatively large-bodied colobines (> 7.2 kg) that live sympatrically with relatively small-bodied hawk-eagles (< 1.7 kg) are probably those least affected by eagle predation, i.e. white-thighed langur and Thomas' langur on Sumatra and ebony langur on Java and Bali. The large size of the female proboscis monkey, in addition to living in more open forest types, probably results in them experiencing less pressure from arboreal predators.

Discussion

The record of predation of a juvenile banded langur by a changeable hawk-eagle is one of the few documented cases of predation by a diurnal raptor on a forest-dwelling primate in Asia (cf. Kirkpatrick 2007). Interestingly, the remaining group members did not respond noticeably to the predation event. A lack of response of Asian colobines to large hawk-eagles has been noted (e.g. snub-nosed monkeys *Rhinopithecus bieti* in the presence of mountain hawk-eagles: Li et al. 2006; grizzled langurs *P. comata* towards Javan hawk-eagles, V. Nijman unpublished data) albeit in these cases predation did not occur. This situation seems to contrast sharply with the situation in African forests where colobines show a range of behavioural responses towards avian predators (Gebo et al. 1994; Shultz and Noe 2002; Shultz et al. 2004).

Compared with, especially, Africa and South America but, to a lesser extent, Madagascar also, predation of primates by raptors in Asia seems to be rarely documented. Although a wealth of primatological research has been conducted in Asia (see reviews in Campbell et al. 2007) as

Table 1 Examples of large prey items caught by three relatively well-studied *Spizaetus* hawk-eagles (with maximum weights of females in brackets), demonstrating their potential as predators of colobines

Species	Country	Prey item	Age (sex)	Mass (kg)	Reference/Source
Mountain hawk-eagle <i>S. nipalensis</i> (3.5 kg)	Japan	Japanese macaque <i>Macaca fuscata</i>	Adult (f)	>8.3	T. Yamazaki in Peregrine Fund (2010)
	Nepal	Red panda <i>Ailurus fulgens</i>	Adult	4.5	G. Regmi, pers. comm. (2010)
	India	Indian peafowl <i>Pavo cristatus</i>	Adult	2.8–4.0	Naoroji (2007)
	India	Yellow throated marten <i>Martes flavigula</i>	Adult	2.0–3.0	Naoroji (2007)
	Taiwan	Formosan serow <i>Naemorhedus swinhoei</i>	Infant	>2.0	Sun et al. (2009)
	Nepal	Assamese macaque <i>Macaca assamensis</i>	Juvenile	2.0	G. Regmi, pers. comm. (2010)
	Japan	Japanese hare <i>Lepus brachyurus</i>	Adult	1.9–2.5	Takayuki et al. (2000); Kaneda (2009)
	Japan	Wild boar <i>Sus scrofa</i>	Infant	1.8	Kaneda (2009)
	Japan	Eurasian badger <i>Meles meles</i>	Infant	1.8	Kaneda (2009)
	Taiwan	Red and white giant flying squirrel <i>Petaurista alborufus</i>	Adult	1.2–1.9	Sun et al. (2009)
	Taiwan	Swinhoe's pheasant <i>Lophura swinhoei</i>	Adult	1.2–1.6	Sun et al. (2009)
	Taiwan	Chinese ferret-badger <i>Melogale moschata</i>	Adult	1.1–1.3	Sun et al. (2009)
	Taiwan	Indian giant flying squirrel <i>Petaurista philippensis</i>	Adult	1.0–1.6	Sun et al. (2009)
	Taiwan	Formosan rock macaque <i>Macaca cyclopis</i>	Infant	>1.0	Sun et al. (2009)
	Changeable hawk-eagle <i>S. cirrhatus</i> (1.9 kg)	India	Lion-tailed macaque <i>Macaca silenus</i>	?	3.0–6.0
India		Indian peafowl <i>Pavo cristatus</i>	Adult	2.8–4.0	Naoroji (2007)
India		Jungle cat <i>Felis chaus</i>	Adult	2.6–12.0	Naoroji (2007)
India		Hispid hare <i>Lepus hispidus</i>	Adult	2.2–2.5	Naoroji (2007)
Malaysia		Banded langur <i>Presbytis femoralis</i>	Juvenile	1.9	This study
India		Black-naped hare <i>Lepus nigricollis</i>	Adult	1.8–3.6	Naoroji (2007)
India		Indian flying fox <i>Pteropus giganteus</i>	Adult	1.3	Naoroji (2007)
Javan hawk-eagle <i>S. bartelsi</i> (1.7 kg)	Indonesia	Long-tailed macaque <i>Macaca fascicularis</i>	?	2.5–5.7	Prawiradilaga (2006)
	Indonesia	Lesser mouse deer <i>Tragulus javanica</i>	Adult	2.0–2.5	Prawiradilaga (2006)
	Indonesia	Malay flying fox <i>Pteropus vampyrus</i>	Adult	1.5	Nijman et al. (2000)
	Indonesia	Ebony langur <i>Trachypithecus auratus</i>	Juvenile	1.5	Nijman et al. (2000)
	Indonesia	Malay stink badger <i>Mydaus javanensis</i>	?	1.4–3.6	Nijman et al. (2000)
	Indonesia	Colugo <i>Cynocephalus variegatus</i>	Adult	1.0–1.3	Prawiradilaga (2006)

Mass is based on information provided by the authors, estimated on the basis of the mass of the respective age-class, or a range is given that is representative for the species in the region it was recorded as prey

indicated by Janson (1998) the most direct method to explore the impact of predation on primate populations is to conduct studies of the predators themselves that would reveal the prey profiles for each predator. *Spizaetus* hawk-eagles are notoriously difficult to observe in the rainforest, and may be rare (Nijman 2004b; van Balen et al. 2000). Thiollay (1985) estimated that on average he observed only one raptor day⁻¹ while walking slowly inside the rainforest. In Japan, mountain hawk-eagles spend 95% of daytime

perched inside the forest, and on 20% of the days observed it does not fly at all (T. Yamazaki personal communication, 1995). Van Balen et al. (2001) reported a maximum encounter rate of 0.9 eagles day⁻¹ for Javan hawk-eagles in the rainforests of Java. Still hunting, whereby the eagle stays perched in the forest, capturing its prey inside the forest, and killing it on the ground, often by suffocation using their talons and pressing the prey on to the ground with their weight, makes it exceedingly unlikely for a

researcher to observe predation directly. Hitherto, few studies have been conducted on the diet of *Spizaetus* hawk-eagles based on long-term observations of active nests. In fact, only three species have been studied as such (Table 1) and for at least 4 species (*S. philippensis*, *S. pinskeri*, *S. kelaarti*, and *S. floris*) nests have yet to be found. We agree with Hart (2007) that if a similar body of research becomes available for Asian raptors as now exists for African birds of prey the picture we have of the impact of birds of prey on Asian colobines may change. Nevertheless with the data available we can make some predictions.

We expect large-bodied colobines living sympatrically with some of the smaller species of *Spizaetus*, for example the white-thighed langur, Thomas' langur, and the ebony langur (excluding Lombok where the relatively large Flores hawk-eagle is present) to show relatively little vigilance behaviour towards arboreal avian predators. Despite our observation in the Panti Forest Reserve, we expect the smaller colobines living sympatrically with large bodied hawk eagles (mountain, Flores, and changeable hawk-eagles) to invest heavily in scanning for arboreal avian predators and, perhaps, in differential calling towards these predators. These include a number of species in different regions, for example banded, mitred, and silvered langur on Sumatra, banded langur on the Thai–Malay Peninsula, silvered and white-fronted langur on Borneo, and possibly also ebony langur on Lombok.

We expect species or populations experiencing higher predation pressure from diurnal raptors to have their daytime resting sites relatively high and more centrally positioned in the canopy (ambush raptors gain most attack velocity in lower strata of the forest: Rettig 1978; Robinson 1994) and, for instance, to show an increase in group size (with an increase in the number of adult males: Miller and Treves 2007; Isbell 1994).

Acknowledgments We thank Drs Donna Hart and KAI Nekaris for information and comments. Ganga Regmi provided information on prey sizes of mountain hawk-eagles in Nepal. V. Nijman acknowledges the Indonesian Institute for Sciences for permission to conduct research in Indonesia. We thank two reviewers for helpful suggestions and comments.

References

- Aimi M, Bakar A (1992) Taxonomy and distribution of *Presbytis melalophos* group in Sumatera, Indonesia. *Primates* 33:191–206
- Ali R (1986) Feeding ecology of the bonnet macaque at the Mundanthurai Sanctuary, Tamil Nadu. *J Bombay Nat Hist Soc* 83:98–110
- BirdLife International (2009) Important bird area factsheet: Panti forest, Malaysia. <http://www.birdlife.org>, Accessed on 2 November 2009
- Campbell CJ, Fuentes A, Mackinnon KC, Panger M, Bearder SK (2007) *Primates in perspective*. Oxford University Press, Oxford
- Collar NJ, Andreev JV, Chan S, Crosby MJ, Subramanya S, Tobias JA (eds) (2001) *Threatened birds of Asia*. BirdLife International, Cambridge
- Ferguson-Lees J, Christie DA (2001) *Raptors of the world*. Christopher Helm, London
- Gebo DL, Chapman CA, Chapman LJ, Lambert J (1994) Locomotor responses to predator threat in red colobus monkeys. *Primates* 35:219–223
- Gonzales RB (1968) A study of the breeding biology and ecology of the monkey-eating eagle. *Silliman J* 15:461–491
- Gunawardena K (2006) A nest of the Black eagle *Ictinaetus malayensis* in Sri Lanka. *BirdingASIA* 6:23–27
- Hart D (2007) Predation on primates: a biogeographical analysis. In: Gursky SL, Nekaris KAI (eds) *Primate anti-predator strategies*. Springer, New York, pp 27–59
- Ibañez JC, Miranda HC, Balaquit-Ibañez G, Afan DS, Kennedy RS (2003) Notes on the breeding behavior of a Philippine eagle pair at Mount Sinaka, Central Mindanao. *Wilson Bull* 115:333–336
- Iida T (1999) Predation of Japanese macaque *Macaca fuscata* by mountain hawk eagle *Spizaetus nipalensis*. *Jpn J Ornithol* 47:125–127
- Isbell LA (1994) Predation on primates: ecological patterns and evolutionary consequences. *Evol Anthropol* 3:61–71
- Janson CH (1998) Testing the predation hypothesis for vertebrate sociality: prospects and pitfalls. *Behaviour* 135:389–410
- Kaneda H (2009) Prey selection and provisioning rate of a breeding pair of Hodgson's Hawk-eagles *Nisaetus nipalensis*. *Ornithol Sci* 8:151–156
- Karpanty SM (2006) Direct and indirect impacts of raptor predation on lemurs in southeastern Madagascar. *Int J Primatol* 27:239–261
- Karpanty SM, Goodman SM (1999) Diet of the Madagascar Harrier-Hawk *Polyboroides radiatus*, in southeastern Madagascar. *J Raptor Res* 33:313–316
- Karpanty S, Wright PC (2006) Predation on lemurs in the rainforest of Madagascar by multiple predator species: observations and experiments. In: Gursky SL, Nekaris KAI (eds) *Primate anti-predator strategies*. Springer, New York, pp 75–97
- Kennedy RS (1985) Conservation research of the Philippine eagle. *Natl Geogr Soc Res Rep* 18:401–414
- Kirkpatrick RC (2007) The Asian colobines: diversity among leaf-eating monkeys. In: Campbell CJ, Fuentes A, Mackinnon KC, Panger M, Bearder SK (eds) *Primates in perspective*. Oxford University Press, Oxford, pp 186–200
- Li D, Grueter CC, Ren B, Zhou Q, Li M, Peng Z, Wei F (2006) Characteristics of night-time sleeping places selected by golden monkeys (*Rhinopithecus bieti*) in the Samage Forest, Baima Snow Mountain Nature Reserve, China. *Integr Zool* 1:141–152
- MacKinnon J (1974) The behaviour and ecology of wild orang-utan (*Pongo pygmaeus*). *Anim Behav* 22:3–74
- Matsuda I, Tuuga A, Higashi S (2008) Clouded leopard (*Neofelis diardi*) predation on proboscis monkeys (*Nasalis larvatus*) in Sabah, Malaysia. *Primates* 49:227–231
- Miller LE, Treves A (2007) Predation on primates: past studies, current challenges, and directions for the future. In: Campbell CJ, Fuentes A, Mackinnon KC, Panger M, Bearder SK (eds) *Primates in perspective*. Oxford University Press, Oxford, pp 186–200
- Naoroji R (2007) *Birds of prey on the Indian subcontinent*. Om Books International, New Delhi
- Nijman V (2004a) Seasonal variation in naturally occurring mobbing behaviour of drongos (*Dicruridae*) towards two avian predators. *Ethol Ecol Evol* 16:25–32

- Nijman V (2004b) Habitat segregation in two congeneric hawk-eagles (*Spizaetus bartelsi* and *S. cirrhatus*) in Java, Indonesia. *J Trop Ecol* 20:105–111
- Nijman V, van Balen S, Sözer R (2000) Breeding biology of Javan Hawk-eagle *Spizaetus bartelsi* in West Java, Indonesia. *Emu* 100:125–132
- Peregrine Fund (2010) Global Raptor Information Network. <http://www.globalraptors.org/grin>, accessed 9 September 2010
- Prawiradilaga DM (2006) Ecology and conservation of endangered Javan hawk-eagle *Spizaetus bartelsi*. *Ornithol Sci* 5:177–186
- Rettig NL (1978) Breeding behavior of the harpy eagle (*Harpia harpyja*). *Auk* 95:629–643
- Robinson SK (1994) Habitat selection and foraging ecology of raptors in Amazonian Peru. *Biotropica* 26:443–458
- Rowe N (1996) The pictorial guide to the living primates. Pogonias Press, East Hampton
- Rowe N, Myers M (eds) (2010) All the World Primates. <http://www.alltheworldsprimate.com>, accessed 9 September 2010
- Shultz S, Noe R (2002) The consequences of crowned eagle central-place foraging on predation risk in monkeys. *Proc R Soc Lond B* 269:1797–1802
- Shultz S, Noë R, McGraw WS, Dunbar RIM (2004) A community-level evaluation of the impact of prey behavioural and ecological characteristics on predator diet composition. *Proc R Soc Lond B* 271:725–732
- Sterck EHM, Watts DP, van Schaik CP (1997) The evolution of female social relationships in nonhuman primates. *Behav Ecol Sociobiol* 41:291–309
- Sun YH, Huang YK, Tsai WH, Hong SY, Chen CC (2009) Breeding-season diet of the mountain hawk-eagle in southern Taiwan. *J Raptor Res* 43:159–163
- Takayuki F, Shin'ichiro F, Ken M, Mami O, Kazuaki T, Yoshio S, Tsuneo S, Yosuke H, Manabu A (2000) Food habits analysis of Hodgson's hawk eagle, *Spizaetus nipalensis* by CCD camera observation system in the breeding season. *Bull Fac Agric Niigata Univ* 53:71–79
- Thiollay JM (1985) Falconiforms of tropical rain forest: a review. In: Newton I, Chancellor RD (eds) Conservation studies on raptors. International Council for the Preservation of Birds, Cambridge, pp 155–165
- Umaphathy G, Kumar A (2000) The demography of the lion-tailed macaque (*Macaca silenus*) in rain forest fragments in the Anamalai Hills, South India. *Primates* 41:119–126
- Van Balen S, Nijman V, Prins HHT (2000) The Javan hawk-eagle: misconceptions about rareness and threat. *Biol Conserv* 96:297–304
- Van Balen S, Nijman V, Sözer R (2001) Conservation of the endemic Javan hawk-eagle *Spizaetus bartelsi* Stresemann, 1924 (Aves: Falconiformes): density, age-structure and population numbers. *Contrib Zool* 70:161–173
- Van Schaik CP (1983) Why are diurnal primates living in groups? *Behaviour* 87:120–144
- Van Schaik CP, van Hooff JARAM (1996) Toward an understanding of the orangutan's social system. In: McGrew WC, Marchant LF, Nishida T (eds) Great ape societies. Cambridge University Press, Cambridge, pp 3–15
- Wells DR (1999) The birds of the Thai–Malay Peninsular, vol I, Non-passerines. Academic Press, London