PREDATOR MOBBING AND INTERSPECIES COOPERATION: AN INTERACTION BETWEEN GIBBONS, LANGURS AND A CLOUDED LEOPARD

Cara H. Wilcox[1*], Supiansyah[1], Abdul Azis K.[1], Zainuddin J.[1], Rahman[1] and Susan M. Cheyne[1,2,3]

[1]Borneo Nature Foundation, Jalan Semeru No. 91, Bukit Hindu, Palangka Raya, Indonesia. E-mail: c.wilcox@borneonature.org, E-mail: supian.bjr@gmail.com, E-mail: azisk789@gmail.com

[2]Faculty of Humanities, Social Sciences and Law, Oxford Brookes University, Oxford OX3 0BP, UK. E-mail: s.cheyne@borneonature.org

[3]School of Anthropology and Conservation, University of Kent, Canterbury, Kent CT2 7NR, UK.

*Corresponding author

ABSTRACT

Anti-predatory interspecific communication is observed between cohabiting species, as well as between prey and predator to communicate detection of 'stealthy hunters'. Predator mobbing is an extension of this communication, with prey species approaching and investigating or harassing a predator. Sunda Clouded Leopard *Neofelis diardi* is a predicted predator of both Bornean White-bearded Gibbon *Hylobates albibarbis* and Maroon Langur *Presbytis rubicunda* in Sabangau Forest, Central Kalimantan, Indonesia. This study reports an event in which gibbons and langurs cooperated in mobbing a clouded leopard. During the event, observers noted that the known c. six-month-old gibbon infant was not with the family group. We explain and contextualise this event in terms of primate cooperation and predator mobbing, both of which are rarely observed phenomena. Further knowledge of these interspecific relationships may help us in creating conservation strategies.

Keywords: *Hylobates*, Interspecific communication, Predator, Prey, *Presbytis*, Primate

INTRODUCTION

Predator mobbing occurs when a prey species approaches and investigates a predator (Clarke, 2010). The likely function of this is to cause a predator to abandon its hunt and leave the area (Lee & Godin, 1992; Zuberbühler et al., 1999). The action of predator mobbing behaviour is described as 'movement towards the predator interrupted with stationary pauses and moves away from the predator' (Lee & Godin, 1992), usually while giving alarms, which are vocalisations produced when there is an urgent threat (Clarke, 2010). Approaching a predator seems illogical given the high potential costs that could occur, as described by Tórrez et al., (2012). The latter authors describe an event where a male White-throated Capuchin *Cebus capucinus* (Linnaeus, 1758) was almost certainly eaten by a Jaguar *Panthera onca* (Linnaeus, 1758) in a mobbing situation. Fatalities such as this are presumably rare otherwise predator mobbing would not have evolved. However, the benefit of predator mobbing is that the predator should leave the area once detected, thus the immediate, and potentially future, danger is reduced (Lee & Godin, 1992). Previous research has shown that when mobbed, Leopards *Panthera pardus* (Linnaeus, 1758) were likely to abort a hunting attempt and leave the area within 10 minutes of being detected (Zuberbühler et al., 1999). If individuals within a group aggressively threaten a predator, this may reduce the likelihood of that predator returning to that area in the future (Lee & Godin, 1992), potentially benefiting the individual attacker's long term fitness.

Alarm calling is described as inter- and intra-specific communication (Stanford, 1998; Zuberbühler et al., 1999; Uhde & Sommer, 2002; Zuberbühler & Jenny, 2002; Clarke, 2010; Burnham et al., 2012; Nijman & Nekaris, 2012), functioning to alert group members and nearby groups to a threat, as well as to communicate to the predator that they have been detected. This is particularly important regarding predators that hunt by stealth, which rely on an element of surprise to catch their prey (Zuberbühler et al., 1999; Zuberbühler & Jenny, 2002; Godin & Davis, 2016); thus predators with

different hunting methods are likely to elicit different responses from prey species. For example, various colobus monkeys have been recorded to alarm call in the presence of Leopards, which hunt by stealth, but not in the presence of Chimpanzees *Pan troglodytes* (Blumenbach, 1799) (Humble et al., 2016), which hunt by pursuit (Stanford, 1998; Zuberbühler et al., 1999; Mitani & Watts, 2001). Consistent results were found in playback experiments; monkeys approached the source of the noise after Leopard vocalisations but not after those of Chimpanzees (Zuberbühler et al., 1999). Thus, predator mobbing is specific to certain predator types, and alarm calling to communicate is only applicable in certain circumstances.

We define cooperation as an interaction between a group of one species and a group of another, in which both groups benefit by acting together (Noe, 2006). Interspecific communication and cooperation also occurs between species in predator defence (Eckardt & Zuberbühler, 2004). Animals adapt to and evolve in environments with other species, and therefore are likely to recognise alarm calls of other species. This may result in heightened vigilance, or alarm calling from two or more species together (Stanford, 1998; Zinner et al., 2001; Uhde & Sommer, 2002; Gil-da-Costa et al., 2003; Nijman & Nekaris, 2012). However, these same species may at other times be in competition over resources. Furthermore, interspecies cooperation may depend on the level of threat, implying some kind of a cost-benefit analysis to determine whether to cooperate or not. Researchers suggest that mixed-species groups are formed mainly for anti-predation benefits (Pook & Pook, 1982; Gautier & Gautier-Hion, 1983; Buchanan-Smith, 1990; Heymann, 1990; Peres, 1993). In some mixed-species groups the different species appear to play different roles in predator avoidance; for example one species may search for aerial predators while the other may search for terrestrial predators (Gautier & Gautier-Hion, 1983; Peres, 1993). In these situations, the anti-predator benefits presumably outweigh competition for resources, and mixed-species groups can be formed.

Langur and gibbon species inhabit similar habitats throughout Asia, and although they occupy different niches (Marshall, 2010) there is still competition between the species. Interactions between them often show gibbons to be dominant over langurs (Elder, 2013). Marshall (2010) describes the distinctions between gibbon and langur niches. The Bornean White-bearded Gibbon *Hylobates albibarbis* Lyon, 1911 is predominantly frugivorous (Marshall et al., 2009; Cheyne, 2010) and plays an important role in seed dispersal (McConkey & Chivers, 2007), whereas the Maroon Langur *Presbytis rubicunda* (Müller, 1838) (Nijman & Meijaard, 2008) eats leaves and a high proportion of unripe seeds (Ehlers Smith et al., 2013).

Predation on gibbons is rarely observed; however, known gibbon predators include leopards, eagles and snakes (Ellefson, 1974; Reichard, 1998; Uhde & Sommer, 2002; Morino, 2011). It has been suggested that gibbons have few potential predators because of their large body size, defensive territoriality, and specialised rapid locomotion (Clarke et al., 2012; Cheyne et al., 2013; however, see also Zuberbühler & Jenny, 2002). The gibbons' specialised locomotion allows them to retreat quickly from a predator, which may make them more able to mob a predator compared with terrestrial primates. Terrestrial primates are thought to be less successful at mobbing (Tórrez et al., 2012), possibly as a result of their less specialised locomotion in comparison to their predators. Arboreal primates have evolved to move quickly through the canopy, whereas predators such as leopards with their less specialised locomotion, are also able to hunt on the ground (Rabinowitz et al., 1987).

Maroon Langur and Bornean White-bearded Gibbon are present in Sabangau Tropical Peat Swamp Forest (TPSF), Central Kalimantan, Indonesia, and behavioural data is regularly collected on both species for the Orangutan Tropical Peatland Project's (OuTrop) research, a programme of the Borneo Nature Foundation (BNF).

Here we report an incident involving predator mobbing and cooperation between Bornean White-bearded Gibbons, Maroon Langurs, and a Sunda Clouded Leopard *Neofelis diardi* (G. Cuvier, 1823). This event has provoked further investigation to look at the interspecific relationships in the forest. Here we aim to explore the factors influencing prey behaviour in terms of predator mobbing and cooperation in the situation described.

METHODS

As part of BNF's ongoing conservation research on primate species, long-term data are recorded on Bornean White-bearded Gibbons (hereafter gibbons in this section) and Maroon Langurs in the Sabangau peat swamp forest, central Kalimantan, Indonesia (Fig. 1).

BNF/OuTrop has been recording behavioural data on gibbons in Sabangau since 2005, and on Maroon Langurs since 2009. Habituated groups of animals

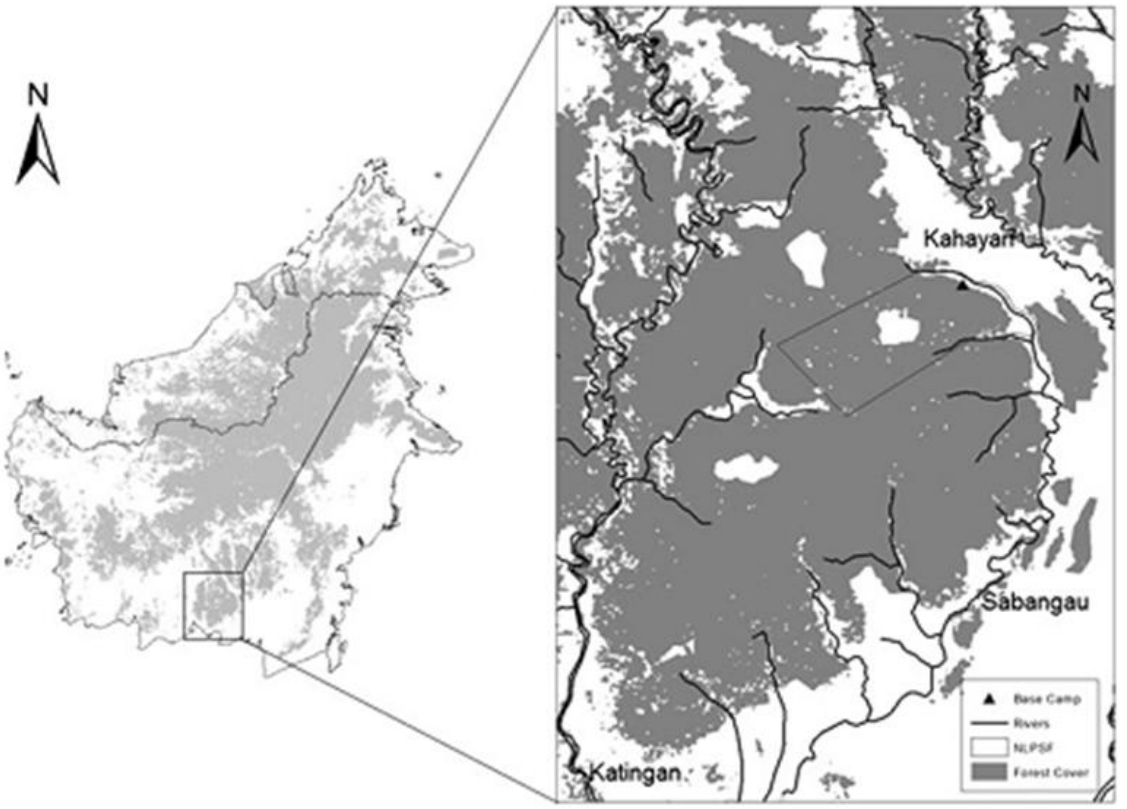

Fig. 1. Maps showing the location of Sabangau Forest, Central Kalimantan, Indonesia (BNF).

were found by searching in known home ranges and were followed from sleeping tree to sleeping tree each month for a maximum of five consecutive days. Experienced staff and researchers observed focal individuals every five minutes, recording behavioural, feeding and ranging data using a defined ethogram and a Garmin GPS (Cheyne, 2010).

The observers also recorded interactions during follows when two primate species were within 15 m of each other. The time, location, group composition, species that approached and left the area, behaviour, and circumstances of the interaction were recorded. To date we have followed gibbons for over 7,870 hours and Maroon Langurs for over 2,580 hours, and this was the first time we have witnessed an interaction like this.

RESULTS

On 7 March 2016, three researchers followed a habituated Maroon Langur group (group BD, nine individuals). The observers began recording data from 05:18 h of a focal individual's first movement from its sleeping tree. At 06:40 h the Maroon Langur group moved towards the direction of the gibbon alarm calls, and at 06:50 h they joined a known gibbon group, Group C. At the last count, on 14 February 2016, Group C comprised an adult pair, a juvenile, and an infant. Both species were alarm-calling constantly; a juvenile Maroon Langur and a juvenile gibbon were observed sitting in the same tree, and no agonistic interaction was observed between the two species. The team noticed that the c. six-month-old gibbon infant was no longer present.

Both groups alarm-called continuously, and at 07:57 h the male gibbon's behaviour was directed at a tangle of lianas c. 14 m up in the canopy. The male gibbon grabbed something in the lianas, shook the lianas and branches, retreated to 4-5 m and vocalised, waited for c. 20 seconds, and then continuously repeated the action. At 08:38 h the team could see there was a Sunda Clouded Leopard among the lianas, while the male gibbon continued with the same behaviour, getting within 2 m of the clouded leopard (Fig. 2). The male Maroon Langur was within 10 m of the clouded leopard and gave alarm calls more frequently than the

other Maroon Langurs. The other gibbons and Maroon Langurs also vocalised throughout this encounter.

At 09:06 h the male gibbon grabbed and released the clouded leopard's tail, which was hanging in the lianas. The leopard responded by drawing its tail towards its body. At this point the leopard was identified as a male, and the team could see its face which was quite alert, looking in the direction of the male gibbon. At 09:34 h the gibbon group moved away from the area, leaving the Maroon Langur group and the clouded leopard. The Maroon Langurs continued to vocalise sporadically. The research team left the Maroon Langurs to follow the gibbon group to see if the infant would appear. The gibbon group split at this time, and the male was recorded travelling in the forest and vocalising (hooting) sporadically. The female and juvenile could not be seen or heard, and the infant was not seen again.

Out of 27 clearly recorded instances of relatively close proximity between gibbons and Maroon Langurs in Sabangau forest from 2005-2014, 55.5% (n=15) resulted in chasing; 29.7% (n=8) when individuals or groups of one species travel through the area in the presence of the other species, but did not exhibit any observable interaction; and 14.8% (n=4) when individuals or groups of both species were observed in the same area, but did not exhibit any observable interaction.

Out of 14 known outcomes of interactions between gibbons and Maroon Langurs in the study area, the gibbons appeared dominant in 12 (86%) and Maroon Langurs were dominant in only two (14%). Dominance is when one or more adults from one group chase another from a different group, usually with alarm calls from one or both groups. Dominance was only recorded during interactions which were clearly described, and when there was displacement with one species successfully chasing away another.

DISCUSSION

During this event, the Bornean White-bearded Gibbons and Maroon Langurs appeared to be cooperating by mobbing the predator. From previous interactions between Bornean White-bearded Gibbons and Maroon Langurs, we saw that most interactions resulted in one species chasing the other away, predominantly the Bornean White-bearded Gibbons chasing Maroon Langurs. Bornean White-bearded Gibbon and Maroon Langur's home ranges in Sabangau overlap, and although they have different ecological niches (Marshall, 2010) they still frequently encounter each other (CW, S, & AK, pers. obs.). A high degree of overlap of ecological niches is likely to result in a higher frequency and intensity of aggressive interactions (Elder, 2013). Sabangau is a non-masting forest, which may mean relatively low competition between

Fig. 2. Adult male gibbon (*Hylobates albibarbis*) mobbing a Sunda Clouded Leopard (*Neofelis diardi*). Photo by Supiansyah and Eko/ BNF.

species, as there is generally a steady availability of food resources such as fruit and leaves (Harrison et al., 2010). At Sabangau and at other field sites, the Bornean White-bearded Gibbon has been recorded to displace the Maroon Langur (Tilson & Tenaza, 1982; Marshall et al., 2009); however, to the authors' knowledge, there are no reports, of cooperation between Maroon Langur and Bornean White-bearded Gibbon. That both species stayed in the same area for over two and a half hours, in the same and adjacent trees is an unusual event in Sabangau (CW, S, & AK, pers. obs.).

Clouded Leopards are a predator of both gibbons (Reichard, 1998; Morino, 2011; Clarke et al., 2012) and Maroon Langur (Nijman & Nekaris, 2012), therefore it is mutually beneficial to address this threat. Mobbing is likely to be more effective with more individuals; thus, predator mobbing may be a unique situation where these species are likely to cooperate.

Gibbon infants usually cling to their mothers for six to eight months, and only begin to make exploratory movements away from the mother after this. Infants will begin to travel fully independently after around two years of age (Treesucon, 1984; Reichard, 2003; Cheyne, 2009; Lappan, 2009). Therefore, it was unusual that the six-month old gibbon infant was no longer observed with the group during this interaction, suggesting a possible predation by the clouded leopard. However, the infant could have disappeared at any point after the group was previously observed (on 14 February 2016), and its disappearance might not necessarily be due to predation by the clouded leopard. The clouded leopard might have happened to be sleeping in the lianas when the gibbons encountered it. However, there is a possibility that the infant gibbon was predated upon by the clouded leopard, and this may have led to the mobbing bout described. Although Sunda Clouded Leopards in Sabangau are predominantly active from 17:00-07:00 h, they are occasionally active during the day (Cheyne & Macdonald, 2011; Cheyne et al., 2013; Adul et al., 2015).

The Maroon Langurs could have moved towards the direction of the gibbons' alarm calls simply to investigate the threat, or possibly they could distinguish the type and nature of the calls. In either case, it appears that these two primate species recognised the threat, and thus by cooperating could be more successful at deterring predation.

CONCLUSION

This rare event is an example of two primate species cooperating to deter a predator, and provides further insight into the dynamics of inter-species associations of the primate community at Sabangau. It is evident that both gibbons and langurs consider the clouded leopard a threat that resulted in these two occasionally competing species to cooperate.

ACKNOWLEDGEMENTS

Sincere thanks to CIMTROP for providing the research permission in the Sabangau Forest's LAHG, to the State Ministry of Research and Technology and Forestry Department of Indonesia for research permission in Central Kalimantan, and to all OuTrop and BNF staff. We thank the reviewers and the editors for their comments and editorial work.

REFERENCES

Adul., Ripoll, B., Limin, S.H. and Cheyne, S.M., 2015. Felids of Sebangau: Camera trapping to estimate activity patterns and population abundance in Central Kalimantan, Indonesia. *Biodiversitas* **16**(2): 151–155.

Buchanan-Smith, H. 1990. Polyspecific association of two tamarin species, *Saguinus labiatus* and *Saguinus fuscicollis*, in Bolivia. *American Journal of Primatology* **22**: 205–214.

Burnham, D., Bearder, S.K., Cheyne, S.M., Dunbar, R.I. and Macdonald, D.W. 2012. Predation by mammalian carnivores on nocturnal primates: is the lack of evidence support for the effectiveness of nocturnality as an anti-predator strategy? *Folia Primatologica* **83**: 236–251.

Cheyne, S.M. 2009. Studying social development and cognitive abilities in *gibbons* (*Hylobates* spp.): methods and applications. **In:** *Primatology: Theories, Methods and Research*, E. Potocki and J. Krasinski (eds.), pp. 1–24. Nova Science Publishers, New York, USA.

Cheyne, S.M. 2010. Behavioural ecology of gibbons (*Hylobates albibarbis*) in a degraded peat-swamp forest. **In:** *Indonesian Primates, Developments in Primatology, Progress and Prospects*, S. Gursky-Doyen and J. Supriatna (eds.), pp. 121–156. Springer Science, New York, USA.

Cheyne, S.M. and Macdonald, D.W. 2011. Wild felid diversity and activity patterns in Sabangau peat-swamp forest, Indonesian Borneo. *Oryx* **45**(1): 119–124.

Cheyne, S.M., Höing, A., Rinear, J. and Sheeran, L.K. 2013. Sleeping site selection by agile gibbons: The influence of tree stability, fruit availability, and predation risk. *Folia Primatologica* **89**: 299–311.

Clarke, E.A. 2010. *The Vocalisations and Anti-predatory Behaviour of Wild White-handed Gibbons (Hylobates lar) in Khao Yai National Park, Thailand.* PhD dissertation, St. Andrews University, Scotland.

Clarke, E., Reichard, U.H. and Zuberbühler, K. 2012. The anti-predator behaviour of wild white-handed gibbons (*Hylobates lar*). *Behavioural Ecology and Sociobiology* **66**: 85–96.

Eckardt, W. and Zuberbühler, K. 2004. Cooperation and competition in two forest monkeys. *Behavioural Ecology* **15**: 400–411.

Ehlers Smith, D.A., Husson, S. and Ehlers Smith, Y. 2013. Feeding ecology of Red Langurs in Sabangau Tropical Peat-Swamp Forest, Indonesian Borneo: extreme granivory in a non-masting forest. *American Journal of Primatology* **75**: 848–859.

Elder, A., 2013. *Competition among three primate species at Way Canguk, Sumatra, Indonesia.* PhD dissertation, Stony Brook University, New York, USA.

Ellefson, J. 1974. A natural history of white-handed gibbons in the Malayan peninsula. **In**: *Gibbon and Siamang: Natural History, Social Behavior, Reproduction Vocalizations, Prehension,* D.M. Rumbaugh (ed.), pp. 1–136. Karger, Basel, Switzerland.

Gautier, J.P. and Gautier-Hion, A. 1983. Vocal behaviour of adult males and superspecific organization in polyspecific troops of monkeys. *Folia Primatologica* **40**: 161–174.

Gil-da-Costa, R., Palleroni, A., Hauser, M.D., Touchton, J. and Kelley, P.J. 2003. Rapid acquisition of an alarm response by a neotropical primate to a newly introduced avian predator. *Proceedings of the Royal Society London B: Biological Sciences* **270**: 605–610.

Godin, J. and Davis, S. 2016. Who dares, benefits: Predator approach behaviour in the Guppy (*Poecilia reticulata*) deters predator pursuit. *Proceedings: Biological Sciences* **259**: 193–200.

Harrison, M., Husson, S.J., D'Arcy, L.J., Morrogh-Bernard, H.C., Cheyne, S.M, van Noordwijk, M.A. and van Schaik, C.P. 2010. *The Fruiting Phenology of Peat-swamp Forest Tree Species at Sabangau and Tuanan, Central Kalimantan, Indonesia.* Report for the Kalimantan Forests and Climate Partnership, Palangka Raya, Indonesia.

Heymann, E.W. 1990. Interspecific relations in a mixed-species troop of moustached tamarins, *Saguinus mystax*, and saddle-back tamarins, *Saguinus fuscicollis* (Platyrrhini: Callitrichidae), at the Río Blanco, Peruvian Amazonia. *American Journal of Primatology* **21**: 115–127.

Lappan, S. 2009. Patterns of infant care in wild Siamangs (*Symphalangus syndactylus*) in Southern Sumatra. **In**: *The Gibbons: New Perspectives on Small Ape Socioecology and Population Biology,* S. Lappan and D.J Whitaker (eds.), pp. 327–345. Springer New York, USA.

Lee, A. and Godin, J. 1992. Prey approaching predators : a cost-benefit perspective. *Annales Zoologici Fennici* **29**: 233–252.

Marshall, A., 2010. Effect of habitat on primate populations in Kalimantan: gibbons and Leaf Monkeys as case studies. **In**: *Indonesian Primates, Developments in Primatology, Progress and Prospects,* S. Gursky-Doyen and J. Supriatna. (eds.), pp. 157–177. Springer New York, USA.

Marshall, A.J., Cannon, C.H. and Leighton, M. 2009. Competition and niche overlap between gibbons (*Hylobates albibarbis*) and Other Frugivorous Vertebrates in Gunung Palung National Park, West Kalimantan, Indonesia. **In**: *The Gibbons: New Perspectives on Small Ape Socioecology and Population Biology,* S. Lappan and D.J Whitaker (eds.), pp. 161–188. Springer Science, New York, USA.

McConkey, K.R. and Chivers, D.J. 2007. Influence of gibbon ranging patterns on seed dispersal distance and deposition site in a Bornean forest. *Journal of Tropical Ecology* **23**: 269-275.

Mitani, J.C. and Watts, D.P. 2001. Why do chimpanzees hunt and share meat? *Animal Behaviour* **61**: 915–924.

Morino, L. 2011. Clouded leopard predation on a wild juvenile Siamang. *Folia Primatologica* **81**: 362–368.

Nijman, V. and Nekaris, K.A.I. 2012. Loud calls, startle behaviour, social organisation and predator avoidance in arboreal langurs (*Cercopithecidae: Presbytis*). *Folia Primatologica* **83**: 274–287.

Noe, R. 2006. Cooperation experiments: coordination through communication versus acting apart together. *Animal Behaviour* **71**: 1–18.

Peres, C.A. 1993. Anti-predation benefits in a mixed-

species group of Amazonian Tamarins. *Folia Primatologica* **61**: 61–76.

Pook, A.G. and Pook, G. 1982. Polyspecific association between S*aguinus fuscicollis, Saguinus labiatus, Callimico goeldii* and other primates in North-Western Bolivia. *Folia Primatologica* **38**: 196–216.

Rabinowitz, A., Andau, P. and Chai, P.P. 1987. The clouded leopard in Malaysian Borneo. *Oryx* **21**: 107–111.

Reichard, U. 1998. Sleeping site, sleeping places, and presleep behavior of gibbons (*Hylobates lar*). *American Journal of Primatology* **46**: 35–62.

Reichard, U.H. 2003. Social monogamy in gibbons: the male perspective. **In**: *Monogamy: mating strategies and partnerships in birds, humans and other mammals,* U.H. Reichard and B. Christophe (eds.), pp. 190-213. Cambridge University Press, Cambridge.

Stanford, C. 1998. *Chimpanzee and Red Colobus: The Ecology of Predator and Prey.* Harvard University Press, Massachusetts, USA.

Tilson, R. and Tenaza, R. 1982. Interspecific spacing between gibbons (*Hylobates klossii*) and langurs (*Presbytis potenziani*) on Siberut Island, Indonesia. *American Journal of Primatology* **2**: 355–361.

Treesucon, U. 1984. Social Development of young gibbons (*Hylobates lar*) in Khao Yai National Park, Thailand. PhD dissertation, Mahidol University, Bangkok, Thailand.

Tórrez, L., Robles, N., González, A. and Crofoot, M. C. 2012. Risky Business? Lethal Attack by a Jaguar Sheds Light on the Costs of Predator Mobbing for Capuchins (*Cebus capucinus*). *International Journal of Primatology,* **33**: 440–446.

Uhde, N. and Sommer, V. 2002. Antipredatory behavior in gibbons (*Hylobates lar*, Khao Yai/Thailand). **In**: *Eat or be eaten*, L. Miller (ed.), pp. 268–292. Cambridge University Press.

Zinner, D., Pelaez, F. and Torkler, F. 2001. Distribution and habitat associations of baboons (*Papio hamadryas*) in Central Eritrea. *International Journal of Primatology* **22**: 397–413.

Zuberbühler, K. and Jenny, D. 2002. Leopard predation and primate evolution. *Journal of Human Evolution* **43**: 873–886.

Zuberbühler, K., Jenny, D. and Bshary, R. 1999. The predator deterrence function of primate alarm calls. *Ethology* **105**: 477–490.