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SHORT COMMUNICATION

INCIPIENT LOSS OF A RAINFOREST MUTUALISM?

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INCIPIENT LOSS OF A RAINFOREST MUTUALISM?

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Abstract: We use data from motion-activated remote cameras to document a commensal, and possibly mutualistic, relationship between Bornean Ground Cuckoos and Bearded Pigs in the rainforests of Kalimantan, Indonesia. We hypothesise that birds benefiting from symbiotic relationships may suffer indirect detrimental effects from hunting that targets large mammals in tropical rainforests.

Keywords: Bird-mammal relationships, Borneo, *Carpococcyx radiaceus*, defaunation, indirect effects, *Sus barbatus*, tropical rainforest.

Birds exhibit important symbiotic relationships with species in other taxonomic groups. For example, the crucial seed dispersal and pollination services they provide to many plant species are well documented (Herrera et al. 1994; Waser et al. 1996). Commensalism and mutualism between birds and mammals, however, remain less well understood. Perhaps the most commonly described ecological interactions between birds and mammals are co-feeding associations in which birds benefit from elevated encounter rates with prey disturbed by foraging mammals (Ruggiero & Eves 1998).

Such relationships are generally commensal and often opportunistic (Dean & Macdonald 1981). Sometimes, however, mammals also benefit from interactions with birds. A well-known example is “cleaner birds”, where mammals profit from the removal of ectoparasites, dead tissue and organic debris (Sazima & Sazima 2010), although this is not the only instance of an avian-mammalian relationship in which both parties benefit. In other observed occurrences, some birds that co-feed with mammals in turn help mammals detect potential predators, resulting in a mutualistic relationship (Rasa 1983).

Most research on bird-mammal relationships originates from more open habitats such as savannah, alluvial or pelagic ecosystems (Dean & Macdonald 1981; Evans 1982; Rasa 1983; Ruggiero & Eves 1998; Komar & Hanks 2002; D’Angelo & Sazima 2014). Anecdotal evidence, however, indicates relationships, of at least a commensal nature, between birds and mammals to be present in tropical rainforests (e.g., Laman et al. 1997; Ruggiero & Eves 1998; Long & Collar 2002; Sazima

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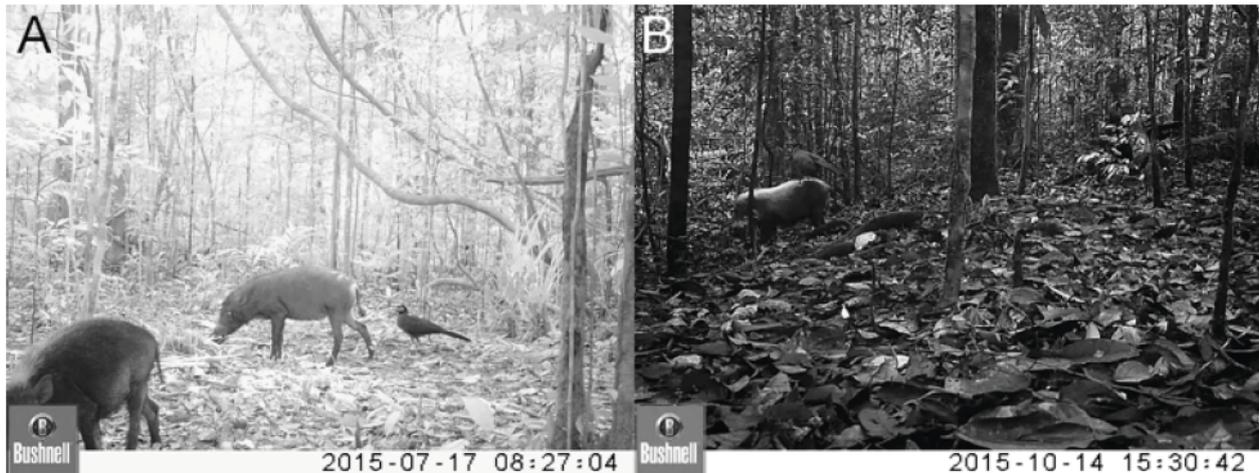


Image 1. Video frames illustrating both sides of the hypothesised mutualism between Bornean Ground Cuckoos *Carpococcyx radiceus* and Bearded Pigs *Sus barbatus*, at the Cabang Panti Research Station, Gunung Palung National Park, West Kalimantan, Indonesia. 1A shows co-feeding behaviour between the cuckoo and two pigs. 1B reveals the cuckoo standing on a pig and presumably scanning their surroundings. © Andrew J. Marshall, Endro Setiawan, and Heiko U. Wittmer.

& Sazima 2010). The limited documentation of these relationships in tropical forests is most likely attributable to the difficulty of detecting and studying cryptic and often rare rainforest species in general, and interspecific interactions in particular.

The Bornean Ground Cuckoo *Carpococcyx radiceus* (BGC hereafter) is a poorly studied rainforest bird species for which reports of commensal relationships with mammals exist (Long & Collar 2002). The BGC is one of the three large, terrestrial cuckoos in the Southeast Asian genus *Carpococcyx*, and endemic to the lowland and hill forests of Borneo. Several reports describe co-feeding behaviour between BGCs and both Bornean Bearded Pigs *Sus barbatus* and Sun Bears *Helarctos malayanus* (Laman et al. 1997; Long & Collar 2002), suggesting that BGCs maintain a commensal relationship with these large mammals. Evidence for this behaviour, however, is based on single observations, most likely because any observation of the elusive BGC is highly unusual, let alone an observation of the species in proximity with another taxon.

We are currently using motion-activated remote cameras to study vertebrate ecology at the Cabang Panti Research Station, Gunung Palung National Park, West Kalimantan, Indonesia (Marshall et al. 2014; Allen et al. 2016). Between July and October 2015, we recorded BGCs on eight occasions at five of 28 cameras spread across the gradient of tropical forest types found at Cabang Panti. We recorded BGS videos in peat swamp ($n = 3$ videos), freshwater swamp ($n = 2$) and lowland sandstone ($n = 3$) forests. On three of these occasions,

at three different localities, we recorded symbiotic behaviour between a BGC and Bearded Pigs. Two videos show BGCs in close proximity to pigs that are feeding on the forest floor. In these recordings, the BGC appears to consume prey items (presumably invertebrates) that are disturbed by the feeding pigs (Image 1A, Video 1, Video 2). On the third video, a Bearded Pig is feeding and a BGC jumps on top of it and appears to scan its surroundings like a sentry (Image 1B, Video 3). The Bearded Pig did not perceptibly respond to this behaviour, suggesting this may be a fairly regular occurrence.

Our data suggest that these relationships play an important role in the behaviour of BGCs as three out of eight videos (38 percent) containing BGCs show interactions with Bearded Pigs. These videos comprise a small proportion of the many hundreds of videos on which we have recorded of Bearded Pigs, which are found in all forest types at our research site (Marshall et al. 2014). The habitats in which BGCs were recorded are consistent with previous reports (Laman et al. 1997; Long & Collar 2002; Fredriksson & Nijman 2004). The behaviour in Image 1B is consistent with the hypothesis that BGCs use pigs as elevated perches from which to hunt (a commensal relationship described by Tomazzoni et al. (2005) for several smaller passerines that use Capybaras, *Hydrochoerus hydrochaeris*, as perches). This hypothesis does not seem very plausible in the case of BGCs. The BGC is a large terrestrial species and therefore unlikely to be dependent on perches to detect prey. We propose an alternative hypothesis: these videos show both sides of a mutualism between BGCs

and Bearded Pigs and illustrate that the relationship is more than opportunistic commensalism. We furthermore propose two ways in which this relationship could be mutualistic: (1) Bearded Pigs may benefit from being alerted to potential predators by BGCs, or 2) BGCs might act as “cleaner birds”. Future investigations are required to assess the validity of these hypotheses. In addition, further work is required to determine whether the other two Southeast Asian, *Carpococcyx* species, Sumatran Ground Cuckoo (*C. viridis*) and Coral-billed Ground Cuckoo (*C. renauldi*), have similar relationships with large mammals.

The BGC is not the only large terrestrial cuckoo in tropical rainforests for which commensal behaviour with large mammals has been reported. The large, terrestrial *Neomorphus* cuckoos, for example, have been reported to associate with Collared Pecaries *Pecari tayacu* and/or White-lipped Peccaries *Tayassu pecari* (López-Lánus et al. 1999). Although reports of interactions among these species remain limited and anecdotal, it is reasonable to expect that further research may show that relationships currently thought to be commensal may be similar to the BGC-Bearded Pig relationship demonstrated here.

Although the precise nature and frequency of interactions between terrestrial birds and large mammals in the tropics is not well characterized at present, symbioses between these groups are common in tropical rainforests around the globe. These relationships rely on the presence of large mammals, which have long been a focus of (subsistence) hunting (Peres 2000). Bornean Bearded Pigs are subject to increasingly heavy hunting pressure throughout their range and are currently considered Vulnerable by the IUCN (2015). Declines in pig abundance will likely limit opportunities for BGCs to interact with them in the future. Indeed, Long & Collar (2002) suggested that the symbiotic relationship between BGCs and Bearded Pigs was more common in the past. It is also intriguing to speculate that symbioses once occurred between BGCs and even larger mammals that are now found at extremely low densities and in limited subsets of their former ranges, such as the Endangered Banteng *Bos javanicus* and the Critically Endangered Sumatran Rhinoceros *Dicerorhinus sumatrensis* (IUCN 2015).

The most commonly attributed cause for the decline of rainforest species is the reduction of forest cover, but as Redford (1992: 421) pointed out, “we must not let a forest full of trees fool us into believing that all is well”. Subsistence hunting, which generally has the greatest impact on species with the largest biomass (Peres 2000; Wright et al. 2007), is known to alter symbiotic

relationships such as seed dispersal and pollination (Redford 1992; Beckman & Muller-Landau 2007; Beaune et al. 2013). We consider it likely that the indirect effects of forest defaunation reach even further, as mammal population declines and changes in species abundances may result in disappearance of interspecific interactions whose ecological importance is poorly understood. The BGC is an unpalatable and smelly species (Long & Collar 2002) and therefore likely to mostly suffer from hunting through accidental by-catch (e.g., in snares). This does not, however, mean that BGCs are not negatively affected by hunting. It may well be that birds exhibiting mutualisms with large mammals are suffering from adverse, indirect effects of the selective defaunation of rainforest ecosystems.

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Video 1. Video showing co-feeding behavior between a Bornean Ground Cuckoo (*Carpococcyx radiceus*) and two Bearded Pigs (*Sus barbatus*). Cabang Panti Research Station, Gunung Palung National Park, West Kalimantan, Indonesia.



Video 2. Video showing co-feeding behavior between a Bornean Ground Cuckoo (*Carpococcyx radiceus*) and two Bearded Pigs (*Sus barbatus*). Cabang Panti Research Station, Gunung Palung National Park, West Kalimantan, Indonesia.



Video 3. Video showing a Bornean Ground Cuckoo (*Carpococcyx radiceus*) jumping on the back of a Bearded Pig (*Sus barbatus*) and presumably scanning their surroundings. Cabang Panti Research Station, Gunung Palung National Park, West Kalimantan, Indonesia.

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Article

Influence of substrate features on distribution of polypores (Fungi: Basidiomycota) in central part of Peechi Vazhani Wildlife Sanctuary, Kerala, India

-- Muhammed Iqbal, Kattany Vidyasagaran & Narayan Ganesh, Pp. 9689–9699

Reviews

Nepal's National Red List of Birds

-- Carol Inskipp, Hem Sagar Baral, Tim Inskipp, Ambika Prasad Khatiwada, Monsoon Pokharel Khatiwada, Laxman Prasad Poudyal & Rajan Amin, Pp. 9700–9722

Current status, distribution and conservation status of Algerian bats (Mammalia: Chiroptera)

-- Mourad Ahmim, Pp. 9723–9733

Short Communications

Incipient loss of a rainforest mutualism?

-- Johannes H. Fischer, Heiko U. Wittmer, Endro Setiawan, Sarah Jaffe & Andrew J. Marshall, Pp. 9734–9737

First record of the Woolly-necked Stork *Ciconia episcopus* Boddaert, 1783 (Aves: Ciconiiformes: Ciconiidae) breeding in the lowland wet zone of Sri Lanka

-- Hemachandra Kularatne & Susantha Udagedara, Pp. 9738–9742

Bibliography and checklist of the dragonflies and damselflies of Bhutan

-- T. Gyeltshen, T. Nidup, P. Dorji, T. Dorji & V.J. Kalkman, Pp. 9743–9747

Checklist of terebrantian thrips (Insecta: Thysanoptera) recorded from India

-- R.R. Rachana & R. Varatharajan, Pp. 9748–9755

Notes

Two jasmine (Oleaceae: *Jasminum* L.) taxa newly recorded in Vietnam

-- Bui Hong Quang, Vu Tien Chinh, Le Thi Mai Linh & Ritesh Kumar Choudhary, Pp. 9756–9760

First record of Rusty-spotted Cat *Prionailurus rubiginosus* (Mammalia: Carnivora: Felidae) from Ramgarh-Vishdhari Wildlife Sanctuary in semi-arid landscape of Rajasthan, India

-- Sailaja Nayak, Sunny Shah & Jimmy Borah, Pp. 9761–9763

Re-sighting record of Fulvous Leaf-nosed Bat *Hipposideros fulvus* Gray, 1838 (Mammalia: Chiroptera: Hipposideridae) from Thar Desert, Rajasthan, India

-- Sumit Dookia, Gajendra Singh & Rajlakshmi Mishra, Pp. 9764–9767

Record number of Yellow-billed Oxpeckers *Buphagus africanus* Linnaeus, 1766 (Aves: Passeriformes: Buphagidae) foraging on a single host

-- Diogo Veríssimo, Jean-Christophe Cugnière, Suzanne Cugnière, Julien Cugnière, Géraldine Cugnière & Laure Cugnière, Pp. 9768–9770

First record of the Two-striped Box Crab *Calappa bilineata* Ng, Lai & Aungtonya, 2002 (Brachyura: Calappidae) from St. Martin's Island, Bangladesh

-- Muntasir Akash & Mostafa A.R. Hossain, Pp. 9771–9773

A record of *Limenitis rileyi* Tytler, 1940 (Lepidoptera, Nymphalidae, Limenitidinae) from Arunachal Pradesh, India

-- Purnendu Roy, Pp. 9774–9776