Aspects of breeding biology and conservation of the Palawan Hornbill *Anthracoceros marchei* in the Palawan Faunal Region, Philippines

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Abstract: Palawan Hornbills occur in three protected areas managed by Katala Foundation, Inc. (KFI), which was established primarily for the conservation of the Philippine Cockatoo *Cacatua haematuropygia* within the Palawan faunal region. Characteristics of nest habitats and nest trees are presented, which may aid habitat restoration efforts for the species. A total of nine nest trees, comprising eight species, were monitored within the cockatoo reserves. Nest trees were canopy-forming or emergent species. Breeding season on Dumaran Island lasted from approximately end of March to mid-July. Clutch size ranged from two to three eggs, with four on one occasion. The average number of chicks fledged was two, although in the nest with four eggs all four chicks fledged. Palawan Hornbills are apparently capable of withstanding a certain degree of habitat degradation. The species is able to forage in closed forests, forest-agricultural landscapes and mangroves, but persistent shifting cultivation, and more recently, mining, biofuel plantations and other larger scale projects, continually reduce suitable habitats. Hunting hornbills for bushmeat is an ongoing threat and almost certainly under-recorded. Nestlings are regularly poached for the pet trade, as indicated by occasional confiscations. In the past years the species has turned up sporadically in the domestic and international wildlife trade. The Palawan Hornbill benefits from the management of cockatoo reserves and forest rehabilitation implemented by KFI and particularly from the wildlife-warden schemes, which have been established at all project sites. Because of its role as seed disperser, the hornbill plays an important role in the forest ecosystem, which can be usefully promoted in conservation education activities.

Keywords: wildlife trade, bushmeat, Philippine Cockatoo, warden scheme, conservation education, Palawan Hornbill, *Anthracoceros marchei*

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INTRODUCTION

The Palawan Hornbill is the sole representative of its family in the Palawan Faunal Region of the Philippines (Kemp 1995). It has been recorded in most of the major islands in the archipelago, namely Palawan, Busuanga (including Calauit), Culion, and Bugsuk (Dickinson et al. 1991; Collar et al. 1999; Kennedy et al. 2000). More recently it has been recorded in Dumaran, Pandanan, and a number of smaller islands in the Bacuit Archipelago. The species is absent from smaller satellite islands in the Sulu Sea, particularly in Honda Bay, Malinau, Aborlan and Rasa Island, Narra (KFI, unpubl. data). The Palawan Hornbill occurs in lowland and hill forests up to circa 900 m asl (BirdLife International 2013) and occasionally enters cultivated areas (Collar et al. 1999). Due to the rapid decline of forests, particularly in the lowlands and because of continued hunting and trapping pressures, the species is currently listed as "Vulnerable" (IUCN 2013).

Very little information on the breeding biology has been published, other than a specimen that was collected from Napsan in the month of April that had enlarged testes, and "… it breeds in the same trees as the Philippine Cockatoo *Cacatua haematuropygia*" (Collar et al. 1999). The species benefits from a nest protection scheme implemented by KFI as part of the Philippine Cockatoo Conservation Programme (PCCP) (Kinnaird and O'Brien 2007). In the framework of this programme, information on the breeding of cavity nesting birds is routinely collected, with priority given to the Philippine Cockatoo and two other parrot species. Therefore data sets for the Palawan Hornbill are not yet complete, but given the paucity of information for this species, particularly in respect to breeding biology, we decided to present new quantitative, though still incomplete, information on nest trees and nest sites, as well as on clutch sizes and nestling survival rates. Since data were gathered in the framework of a community-based warden scheme, often involving people with little experience with hornbills, we attempted to keep disturbance of nests to a minimum. As such, other aspects of breeding biology of Palawan Hornbill, like feeding intervals at the nest, duration of incubation and nestling development were not systematically investigated.

MATERIALS AND METHODS

Nests of cavity nesters were searched for in all three project sites in the course of the wildlife warden scheme of the PCCP. Up to 53 criteria were recorded for the nest trees and their surrounding environment. Since data for hornbill nest sites are not yet complete, only basic measurements of nest trees and cavities are presented in this paper. Nest trees were

identified to the lowest taxonomic level possible, sometimes with the help of herbarium specimens. Height of trees and nest holes were measured with clinometers. Dimensions of nest cavities were measured with metric tapes and tree diameters with tapes at breast height (1.3 m) or above buttresses. Nest trees were monitored during the breeding season in the course of other patrolling or research activities. Behavioral observations on active nest trees were made opportunistically.

Information on threats were collected over many years at the project sites and in other areas of Palawan through personal observations of habitat destruction and degradation, trade and hunting as indicated by confiscation, ethno-zoological interviews and screening of websites offering the species for sale and from records of the Department of Environment and Natural Resources (for confiscations within Palawan and export permits issued for the Palawan Hornbill).

The PCCP aims to be comprehensive in its conservation approach; its main components are a warden scheme employing ex-poachers, protected area management, conservation education employing the Pride methodology, which applies social marketing strategies to conservation education as well as law enforcement and advocacy, forest rehabilitation (with an aim for restoration) and applied research (Widmann and Widmann, 2008, 2011; Widmann et al. 2006). We assess how the Palawan Hornbill benefits from these activities and how it can be included in the overall conservation strategy.

Study sites

We collected data from the three project sites of the PCCP which contain populations of Palawan Hornbills (Figure 1).

- Omoi and Manambaling Cockatoo Reserves, Dumaran: Dumaran Island is situated in northeastern Palawan (10°22' - 10°41'N 119°28' - 119°55'E). The terrain of the island is rolling with the highest elevation reaching only 120 m asl. No permanent river systems or lentic water bodies exist. Only few small and isolated forest patches remain, none of them larger than 103 ha (Omoi Cockatoo Reserve). Manambaling Cockatoo Reserve covers 50 ha. The two reserves are dominated by evergreen and semi-evergreen lowland forest with Ipil *Intsia bijuga* and Amugis *Koordersiodenron pinnatum* representing emergent tree species of commercial value. Currently, reforestation efforts are under way for the buffer zones and a corridor connecting the two reserves. The main forms of land use are upland slash-and-burn agriculture ('*kaingin*'), which is still widespread. As a consequence of this practice a large part of the island is covered by grass, shrubs and dense stands of bamboo. Permanent forms of cultivation are coconut and cashew plantations. Forest and grass fires are common, particularly during the dry season. Illegal logging is widespread.

- Culasian Managed Resource Protected Area (CMRPA), Rizal: This protected area (8°52' - 8°47' N 117°27' - 117°31'E) is situated in the coastal plain facing the South China Sea. It covers an area of 1,954 ha. CMRPA ranges from sea level to approximately 140 m asl. The terrain is flat in the narrow coastal area and rolling to moderately steep in the remaining portions. Two permanent rivers mark the periphery of CMRPA: Culasian River in the north and Arapitan River in the south. Smaller ephemeral creeks and stagnant water bodies can be found inside the area. The major terrestrial ecosystem in the protected area is lowland dipterocarp forest. Forest canopies often reach 30-40 m. *Dipterocarpus grandiflorus* and *Koompassia excelsa* are the most conspicuous emergent tree species, with the latter reaching more than 70 m in height. Other emergent species include *Dipterocarpus gracilis, Dipterocarpus hasseltii, Intsia bijuga* and *Koordersiodendron pinnatum*. Flat and rolling areas are dominated by permanent cultivation, mostly irrigated and rain-fed rice paddies, coconut plantation and pastures. Shifting cultivation is most common along the roads, but can frequently be found isolated in forested areas, often on steep slopes. Emergent isolated trees in cultivated areas are nest sites of hornbills, parrots or mynas 'owned' individually by poachers ('poacher trees'), and therefore spared when the area was cleared.
- Pandanan Island, Balabac: Pandanan is one of the smaller islands within the Balabac Group situated at the southern tip of mainland Palawan. Coastal forests are dense and grow on flat limestone originating from elevated coral reefs. Large trees in the coastal forest are mostly deciduous and widely spaced due to water stress during the dry season. The understory is very dense with abundant vines. Emergent trees comprise the genera *Dipterocarpus, Pometia* and *Ficus*. A narrow rim of beach forest with *Erythrina, Calophyllum* and *Barringtonia* is present. The dense coastal forest cover is well protected because a large portion of the island is privately-owned and visitors are monitored by private guards. Coconuts are the major crop in the coastal areas and shifting cultivation including lowland rice, corn and root crops inside forested areas are common land use forms.

RESULTS AND DISCUSSION

Breeding biology

We monitored nine nest trees comprising eight species, of which five were identified to species level and two to genus. One dead nest tree without leaves or bark remains unidentified (Table 1). At least four trees (*Azadirachta, Koompassia, Pongamia, Terminalia*) are very tall and are regularly present as emergents. These species are also utilized by other

cavity nesting species in Palawan, particularly Philippine Cockatoos, Blue-naped Parrots *Tanyganthus lucionensis*, and Hill Myna *Gracula religiosa*. Of these, *Koompassia excelsa* has long been considered the tallest rainforest tree species (Whitmore 1972). Within the Philippines it is restricted to the southern portion of Palawan where it plays a major role for cavity nesters and bird poachers alike (Orbeta 2004). The remaining three species were canopy-forming.

Average tree height was 43.4 m (15-70 m; n = 5), average diameter 110 cm (41-143 cm; n = 5). The two *Koompassia* nest trees were solitary within old shifting cultivation areas in CMRPA, the *Cleistocalyx* was situated at the forest edge and the remaining trees were within closed forest. Two nest trees were dead (22%), whereas six appeared to be healthy (78%). The average height of nest holes was 30.2 m (9-56 m; n = 5). Nest cavities in six trees were situated on the main trunk (67%) and in three trees on leading branches (33%). Nest cavity dimensions were on average 49 cm (37-69 cm; n = 3) high and 24 cm at the widest point (18-33 cm; n = 3). The large size classes of nest trees recorded are certainly due to the fact that sampling size was small and included two very tall *Koompassia*.

The breeding season for Palawan Hornbills in Dumaran spans from the last quarter of the dry season (end of March) to the middle of the rainy season (end of July). The same nest trees were used over a number of years, with the longest recorded period being five consecutive years. One female was observed to seal nest entrance from outside and later from inside, using orange-coloured fruit pulp containing very small seeds (possibly *Ficus*). Timing of egg-laying after sealing of the nest hole is not known. Clutches of monitored breeding attempts consisted of two (n = 6), three (n = 2) or four eggs (n = 1) (Figure 2). Survival rate of nestlings to fledging stage was 82% in 12 nesting attempts. One observed cause of breeding failure was the collapse of a nesting tree, killing the female and two nestlings.

Exact incubation and nestling periods could not be observed, but are estimated respectively to be around 28 and more than 50 days. Food items brought to the nest by the male included fruits, an Emerald Tree Skink *Lamprolepis smaragdina*, and other unidentified lizards. A midden was noted to have seeds of at least 13 species, of which four genera could be identified: *Syzygium, Canarium, Eleocarpus* and *Garcinia*.

Threats

The core habitat of the Palawan Hornbill is old-growth dry lowland and hill forest, where the highest population densities were recorded, whereas the species was not recorded in cultivated areas (Mallari et al. 2011). However, in Dumaran and Rizal the species was regularly encountered in tree-dominated agricultural areas (fruit orchards, shifting cultivation with remnant “poacher trees”); if suitable nest trees exist,

breeding occurs in these semi-open areas. We suspect that nest trees may be the limiting factors in these largely human-influenced systems, since large and potentially suitable trees are usually cleared to make way for agriculture, or logged for timber or firewood.

Palawan in its entirety has been declared a Biosphere Reserve (UNESCO's Man and Biosphere Programme), though lowland forest is still declining. Due to the unique provisions of the Strategic Environmental Plan for Palawan, the least protected forests are the most diverse lowland forests, which are also most valuable for the Palawan Hornbill and other cavity nesters. However, even demarcated core and restricted use zone forests are occasionally declassified for other uses by the Palawan Council for Sustainable Development. Reasons for forest loss include shifting cultivation and illegal logging, but increasingly also large-scale projects, including mining and biofuel plantations (Lasmarias 2004; Orbeta 2004), and possibly also infrastructure projects related to tourism.

The species is traditionally hunted for food, like most other hornbill species in the Philippines (Gonzalez 2011), but quantitative information is mostly anecdotal and overall effects on the population are unknown. Fifty hunters interviewed in Rizal, southern Palawan, stated that they took 17 hornbills in one year, of which 14 were meant for their own consumption. However, almost all declared that they use bushmeat occasionally for bartering (Villafuerte-van den Beukel et al. 2009). If these figures could be confirmed for other regions of Palawan, then hunting for food would have a much higher impact on hornbill population compared to the pet trade. Adult birds are usually shot with air-guns or home-made front-loader guns, whereas chicks and incubating females are taken from nests. Palawan Hornbill meat, like other bushmeat, is popular as snack ("*pulutan*") accompanying drinking sessions.

Palawan Hornbills are occasionally traded as pets domestically and internationally. Seventeen wildlife traders have been identified from southern Palawan alone, and between 2000 and 2006 a total of 38 birds were confiscated in this province (Cruz et al. 2009) (Figure 3). However, since no indicators for law-enforcement or poaching efforts are available, no clear trend in trade can be extracted from the data. Internet searches revealed that the species is occasionally offered for sale online. Particularly, offers from domestic trade platforms like sulit.com should be thoroughly scrutinized, since they almost certainly include illegally acquired animals. A zoo in Novosibirsk, Russian Federation, acquired a young pair of Palawan Hornbills in 2012 from unknown sources (R. Wirth in litt. December 2012). The Department of Environment and Natural Resources issued export permits for 19 Palawan Hornbills from two facilities in Manila between 2008 and 2013 (DENR-PAWB in litt. April 2013), but no permit was issued to the zoo in Novosibirsk.

Conservation

The Palawan Hornbill is present in a number of protected areas, most importantly El Nido-Taytay Managed Resource Protected Area, Puerto Princesa Subterranean River National Park and Mantalingahan Protected Landscape. The species is also recorded from three out of four sites managed under the Philippine Cockatoo Conservation Programme (study sites with breeding records for the species). Due to its habitat requirements, all cockatoo reserves are situated in coastal areas, which are under immense pressure from human populations and therefore pose particular conservation challenges. Although these reserves are mostly small, ranging between 0.5 and 39 km^2 in area, they contain large percentages of Palawan's threatened vertebrate assemblages. In two of these cockatoo reserves, 60% of globally threatened terrestrial mammals and 67% of globally threatened bird species recorded for the island can be found. All sites benefit from community-based warden schemes. Wildlife wardens, mostly ex-poachers, patrol the areas and monitor wildlife populations, particularly cavity-nesting bird species. These schemes have the advantage of providing poachers with a legal source of income while immediately removing hunting and trapping pressure on wildlife population, as well as adding local knowledge to conservation efforts (Widmann et al. 2006). Cockatoo reserves are either privately or publicly owned, the latter are declared as protected areas on municipal or national levels. As a result of the warden scheme, no recorded hornbill nest tree in any of the cockatoo reserves was cut down or poached for birds since the start of the projects in 2002 and 2007 respectively.

Hunting and trapping of Palawan Hornbill in cockatoo reserves is addressed through the warden schemes as well. These have resulted in a number of confiscations, all from CRMPA and surrounding areas. However, none of these has ever led to prosecution of notorious traders, presumably because wildlife crime is not ranked very high on the agenda of local courts and some traders are politically well connected.

Due to the vicinity to human settlements, conservation education for coastal biodiversity is of utmost importance. KFI utilizes the Pride methodology employing social marketing strategies. The role of ecosystems and species for the welfare of people is highlighted; for example the protection of mangroves as nurseries for economically important fish and crustacean species, or the protection of riparian forest to prevent riverbank erosion. Although cockatoos can disperse seeds in certain circumstances, they do so over short distances, while destroying a very high percentage of these seeds. The Palawan Hornbill on the other hand is an effective seed disperser and is regularly used as an example of a species providing ecosystem services in conservation education campaigns. Consequently hornbills feature prominently in lectures, on posters, in puppet theatres or face-painting activities (Figure 4).

Rehabilitation of coastal forest areas is a strategy to increase potential habitat for flora and fauna of lowland forests in Palawan. For many years KFI has conducted experimental reforestation, testing performance of mostly native tree species in respect to survival rates and growth performance. Depending on the site conditions, assisted natural regeneration and/or enrichment planting methods are applied (Widmann and Widmann, 2011). Reforestation efforts have been focused in the buffer zones of the very small cockatoo reserves on Dumaran Island and one of the last remaining lowland dipterocarp forest patches stocking on limestone in the Sulu Sea coastal plain. In 2012, the creation of a forest corridor between two cockatoo reserves in Dumaran was initiated, which will eventually cover 256 ha. Among the propagated tree species are also six nest-providing and eight food-providing plants for hornbills. For some of the latter, seeds were collected from hornbill nest middens. Seeds acquired in this way could be directly propagated in tree nurseries, since most of them were still viable.

CONCLUSIONS

Given the conspicuousness of the Palawan Hornbill and the relatively easy accessibility of some of its habitats, it comes as a surprise that no studies devoted to this species have been conducted previously. Although its breeding biology seems to be similar in many aspects to other *Anthracoceros* species (Kemp 1995), intensive nest monitoring may fill the gaps in our knowledge of this species. Information on feeding biology, particularly on food plants, would have an added applied conservation value by increasing the number of species that could be incorporated in habitat rehabilitation schemes.

Systematic population estimates and nest counts at different altitudes may provide better estimates for the global population of the species. It may also lead to better informed management of forest areas in Palawan, since paradoxically highly diverse and threatened lowland forest are less well protected than the less diverse and more secure forests in higher altitudes. Forest areas with Palawan Hornbill populations would qualify as "core zones" under the Strategic Environmental Plan of Palawan and should be declared as such by the Palawan Council for Sustainable Development. Quantitative information on how Palawan Hornbill populations react to hunting and trapping would provide a more solid foundation to inform and mobilize law enforcers and prosecutors.

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Table 1. Measurements of nest trees and nest cavities of Palawan Hornbill.

Tree species	Family	Tree height (m)	Tree DBH (cm)	Nest height (m)	Vertical cavity dimension (cm)	Horizontal cavity dimension (cm)
Azadirachta excelsa (*n* = 1)	Meliaceae	47	52	17	69	33
Cleistocalyx sp. (*n* = 1)	Myrtaceae	20	41	18	37	18
Koompassia excelsa (*n* = 2)	Fabaceae	67.5	128	53.5	-	-
Pongamia pinnata (*n* = 1)	Sapindaceae	15	76	9	41	22
Syzygium claviflorum	Myrtaceae	-	-	-	-	-
Syzygium sp.	Myrtaceae	-	-	-	-	-
Terminalia calamansanai	Combretaceae	-	-	-	-	-
Unidentified sp.	Unidentified	-	-	-	-	-

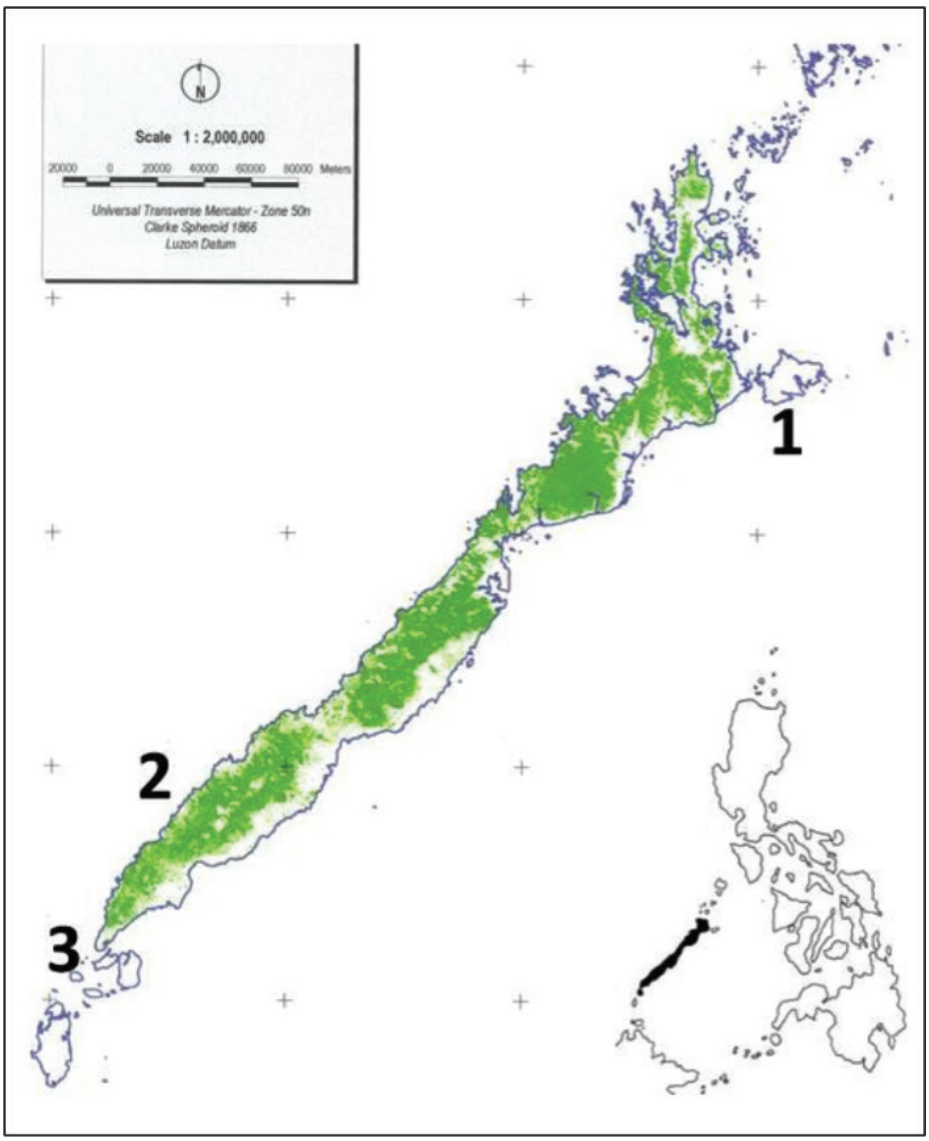

Figure 1: Forest cover (shaded) and location of study sites within Palawan: 1) Omoi and Manambaling Cockatoo Reserves, Dumaran, 2) Culasian Managed Resource Protected Area (CMRPA), Rizal, 3) Pandanan Island, Balabac. Inset: Location of Palawan within the Philippines (Map Source: Palawan Tropical Forestry Conservation Programme).

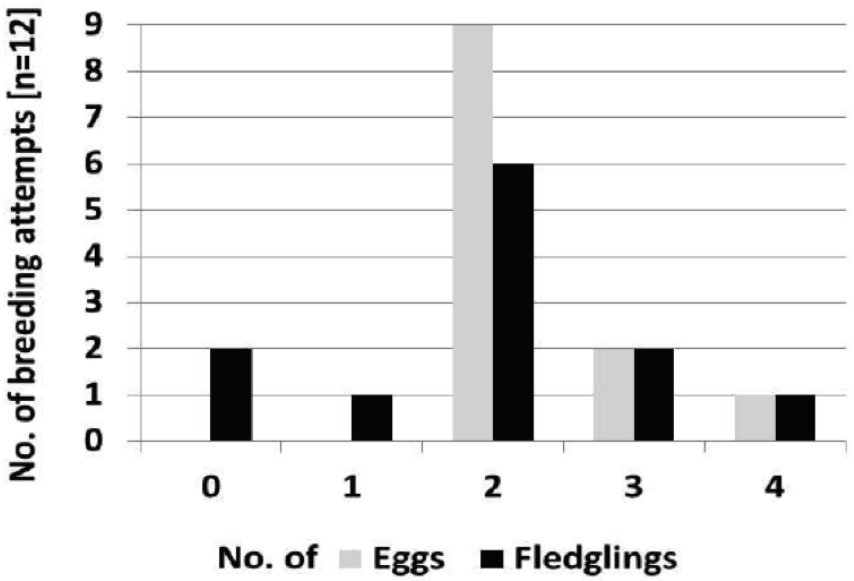

Figure 2: Clutch sizes and numbers of fledglings in relation to 12 breeding attempts of Palawan Hornbills.

Figure 3: Palawan Hornbill and Blue-naped Parrot nestlings confiscated from a wildlife trader in southern Palawan (Photo credit: KFI).

Figure 4: Palawan Hornbills are utilized in a number of methods for conservation education, including (above) face-painting and (below) puppet theaters. (Photo credits: KFI)