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VARIABILITY IN GUT PASSAGE TIMES OF ASIAN HORNBILLS

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ABSTRACT

Seed gut passage time through animals influence germination and displacement distance of seeds from parent plants. Hornbills are the largest avian seed dispersers in Asian tropical forests. In this study, we compared gut passage times for five large seeded tree species across gut passage trials, for three hornbill species. This study was conducted on six captive birds in Nagaland, India. The gut passage time of seeds for the tree species varied from 5 to 536 minutes. There was no difference in gut passage times between trials, between male and female birds and different fruit tree species for the Oriental Pied Hornbill. For the Rufous-necked Hornbill, we found differences in gut passage times across trials for Beilschmiedia assamica and Polyalthia simiarum, between individuals for Livistona jenkinsiana and across tree species, especially for the female. For the Wreathed Hornbill, we found differences in gut passage times across trials for Aglaia spectabilis and Syzygium cumini, between individuals for Beilschmiedia assamica and Livistona jenkinsiana and across tree species only for the female bird. Mean gut passage times reported here are higher than those reported previously for Asian hornbills. Context-specific variability in gut passage times highlights the need to examine the causes that result in these inconsistent patterns.

Keywords: *Aceros nipalensis*, *Anthracoceros albirostris*, frugivores, large-seeded fruits, *Rhyticeros undulatus*, seed dispersal, seed retention

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Abstract
Seed gut passage time through animals influence germination and displacement distance of seeds from parent plants. Hornbills are the largest avian seed dispersers in Asian tropical forests. In this study, we compared gut passage times for five large seeded tree species across gut passage trials, for three hornbill species. This study was conducted on six captive birds in Nagaland, India. The gut passage time of seeds for the tree species varied from 5 to 536 minutes. There was no difference in gut passage times between trials, between male and female birds and different fruit tree species for the Oriental Pied Hornbill. For the Rufous-necked Hornbill, we found differences in gut passage times across trials for *Beilschmiedia assamica* and *Polyalthia simiarum*, between individuals for *Livistona jenkinsiana* and across tree species, especially for the female. For the Wreathed Hornbill, we found differences in gut passage times across trials for *Aglaia spectabilis* and *Syzygium cumini*, between individuals for *Beilschmiedia assamica* and *Livistona jenkinsiana* and across tree species only for the female bird. Mean gut passage times reported here are higher than those reported previously for Asian hornbills. Context-specific variability in gut passage times highlights the need to examine the causes that result in these inconsistent patterns.

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INTRODUCTION

Hornbills are among the largest avian frugivores in Asian tropical forests. They play an important quantitative role and qualitative role in seed dispersal (Kitamura 2011). Due to their large body size, they feed on large number of fruits playing an important quantitative role in seed dispersal (Sethi & Howe 2012). Their ability to swallow large-seeded fruits and disperse the seeds unharmed at significant distances from their parent trees makes them important qualitative seed dispersers (Kemp 1995; Holbrook *et al.* 2002; Keartumsom *et al.* 2011; Viseshakul *et al.* 2011).

Hornbills defaecate the tiny seeds of *Ficus* sp. and a few other small-seeded species, but generally regurgitate large seeds. For some tree species, dispersal by hornbills is known to enhance seed germination (Whitney *et al.* 1998; Datta 2001). They have relatively long gut retention times as compared to other avian frugivores (Holbrook & Smith 2000). Gut passage time or gut retention time is a key parameter that enables the estimation of dispersal distances of hornbill-dispersed seeds. Estimates of gut retention times for the *Ceratogymna* and *Bycanistes* hornbills in Africa in conjunction with fine-scale movement data has enabled estimation of dispersal distances of seeds which were estimated to be as far as 14 km from the parent tree (Holbrook & Smith 2000; Lenz *et al.* 2011).

Gut passage times are known to be a function of body size. Frugivorous hornbills vary in size from 230 g to 4000 g. However, data on their gut passage times is mostly known from only the larger-bodied hornbills. Gut passage times of food plant species is known only for three African hornbill species (Holbrook & Smith 2000; Lenz *et al.* 2011) and a few Asian hornbill species (Leighton 1982; Lambert 1989; Datta 2001). Among Asian hornbill species, data on gut passage times comes primarily from hornbills belonging to the genus *Buceros* (Great Hornbill and Rhinoceros Hornbill) with very limited information for other genera (Leighton 1982; Lambert 1989; Datta 2001).

In this study, we report gut passage times for two medium-sized hornbill species, the Rufous-necked Hornbill *Aceros nipalensis* and the Wreathed Hornbill *Rhyticeros undulatus* and a small-sized hornbill species, the Oriental Pied Hornbill *Anthracoceros albirostris.* The gut passage times were estimated for five relatively large-seeded tree species which are important hornbill food plants. The data was systematically collected across several trials. We compared the gut passage times of the different tree species across the different trials to determine if there are significant variations across trials for each tree species for each individual hornbill, thereby highlighting the need to carry out repeated trials in future experiments. We also compared gut passage times across individuals of the three hornbill species and across different tree species for each individual hornbill.

MATERIALS AND METHODS

This study was carried out at the Nagaland Zoological Park (NZP) in Dimapur District of Nagaland in north-east India. NZP (25°51’19.24” N, 93°43’14.23” E) is a part of the Rangapahar Wildlife Sanctuary.

Hornbills in Nagaland Zoological Park

During the time of the study, NZP housed a single female of the Great Hornbill *Buceros bicornis*, a pair each of the Wreathed *Rhyticeros undulatus* and the Rufous-necked Hornbill *Aceros nipalensis* and three pairs of the Oriental Pied Hornbill *Anthracoceros albirostris* among other animals. All the hornbills housed at the zoo were either donated by citizens or rescues from the local wildlife trade markets. The female Great Hornbill, whose age was not known, was housed in a separate enclosure. The two Wreathed Hornbills and the female of the Rufous-necked Hornbill were between 4–5 years of age, while the male Rufous-necked Hornbill was about 2 years old, as indicated by the Zoo Biologist and the Ranger who was in-charge of the zoo. These four individuals were housed together in a large enclosure. The six Oriental Pied Hornbills were housed in a separate enclosure with one pair being housed in separate, smaller individual spaces within the larger enclosure. The Wreathed (84–117 cm, 1360–2650 g) and the Rufous-necked hornbills (99–122 cm, 2270–2500 g) are considerably larger than the Oriental Pied Hornbills (60–85 cm, 500–907 g) (Kemp 1995). All the hornbills were housed in the tourism zone of the zoo, and were found to be quite tame and comfortable having visitors around.

Fruit species for the gut passage time study

Five hornbill food tree species, *Aglaia spectabilis* (Assamese name: Amari), *Beilschmiedia assamica* (Assamese name: Bonsum), *Livistona jenkinsiana* (Assamese name: Toko), *Polyalthia simiarum* (Assamese name: Kari) and *Syzygium cumini* (Assamese name: Khowa Jamun) were selected for determining the gut passage times. The details of fruits and seeds of the five tree species are in Table 1. All the five species are medium- to large-seeded hornbill food tree species (seed size ≥ 15 mm). While *B. assamica* and *L. jenkinsiana* are important food plants during the non-breeding season (September–February), *A. spectabilis* and *S. cumini* fruit during the breeding season of hornbills between March–August (Datta 2001; Datta & Rawat 2003; Naniwadekar *et al.* 2015). *P. simiarum* fruits across eight months in Pakke Tiger Reserve and is thus an important hornbill food plant both in the breeding and the non-breeding season of hornbills (Datta 2001; Datta & Rawat 2003).