

Artificial incubation and hand rearing of Great Pied Hornbill *Buceros bicornis* following cannibalism of chicks by parents

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Abstract: : The Great Pied Hornbill *Buceros bicornis* also known as the Great Indian Hornbill, is one of the largest species of hornbill in the world. It is 93 - 129 cm long, has a wingspan of 152 cm and weighs from 2.15 - 4 kg. The species can be found in India, Indonesia, Malay Peninsula and Sumatra. It is listed as Near Threatened under the IUCN Red List of Threatened Species and the population is declining. This can be attributed to habitat destruction, mainly caused by logging and clearing of forests. They are also hunted for their casques which are kept or sold as trophies. At the Jurong Bird Park, a breeding pair of Great Pied Hornbill has successfully bred three times. During the breeding season in 2010, the female Great Pied Hornbill laid three eggs, but none of the three hatchlings survived as they were cannibalized. This was observed on infrared cameras used to monitor the birds. During the breeding season in 2011, because of its previous breeding history, three eggs were pulled out from the nest and artificially incubated at the “Breeding and Research Centre” at Jurong Bird Park. Two out of three eggs successfully hatched. The two chicks were hand raised and subsequently released into the “Hornbill and Toucan” exhibit. In 2012, another Great Pied Hornbill chick was removed from its nest and successfully hand-raised until it was weaned. Artificial incubation and hand-rearing of this species can contribute to higher breeding success in captivity.

Keywords: Great Pied Hornbill, *Buceros bicornis*, cannibalism, artificial incubation, Jurong Bird Park

INTRODUCTION

The Great Pied Hornbill *Buceros bicornis* is one of the largest members of the hornbill family. It has a large, yellow and orange bill with a large, yellow casque (Tsuji and Poonswad 1996). During breeding season they are known to form monogamous bonds (del Hoyo et al. 2001). The remarkable nesting habit of the Great Pied Hornbill is such that the

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female seals herself inside the nest box leaving only a narrow opening for her mate to pass food to her, and later to the chicks (Kemp, 1995; Poonswad et al. 1998).

In the 40 years of Jurong Bird Park's history, hornbills have always played a very important part of its avian collection. Currently housing 17 species of hornbills, five of which are African, the park has accumulated a lot of data on breeding these magnificent birds.

In the hornbill breeding season of 2010, a pair of Great Pied Hornbills was monitored via CCTV cameras 24/7. This pair has been with us for the past 15 years. The provision of a suitable-sized aviary, suitable nutrition and artificial nest box design and careful observation resulted in the successful breeding of this species. Three eggs were laid, all of which hatched but were cannibalized by the parents.

In the breeding season of 2011, having learnt from the previous breeding season, three eggs were laid and pulled out after two weeks of incubation and transferred to the Breeding and Research Centre for artificial incubation and hand rearing (Figure 1).

In the breeding season of 2012, three eggs again were laid, of which one broke, one was infertile and one hatched. At around the tenth day of hatching, it was observed that the female stopped feeding the chick. Fearing the chick might die, it was pulled out and sent for hand rearing.

This paper reviews the methods, diet, incubation and feeding protocol of hand-raising the Great Pied Hornbill chicks.

BREEDING HISTORY AND CONDITIONS

Breeding season 2010

During the 2010 breeding season in Jurong Bird Park, data for Great Pied Hornbill breeding behaviour was recorded using CCTV cameras 24/7. On 3 February 2010, the female laid its first egg and on the 8 February, it laid its second egg (Figure 2A). Despite having laid two eggs, the female had yet to cease sealing the hole of the nest. The female spent most of her time incubating its eggs, turning them one at a time.

Since the morning of 14 February, the female Great Pied began ignoring her eggs; and left two of its eggs at the corner of its nest box (Figure 2B). This was worrying as the chances of hatching depend on the ability of parents to regulate the eggs' immediate environment within narrow limits. Thus, without the female incubating and turning the eggs, the embryos might die of uneven heat distribution or the growth of extra embryonic membranes and fluid dynamics might be retarded. On 15 February, the third egg was sighted (Figure 2C), bringing the clutch size to a total of three.

On 3 March, it was observed that the female hornbill was incubating all her eggs and none of them had hatched yet. According to del Hoyo et al. (2001), the incubation period is approximately 40 days. With that knowledge, the expected dates of hatching were gauged.

On 11 March, the first chick hatched, three days earlier than the expected date. The next day, at 1156 hours, tragedy struck when the female Great Pied ate its chick (Figure 2D). It was observed that the hatchling was still alive at 1102 hours, opening and closing its beak in a “calling out” motion. This indicates the hatchling was not a stillborn.

On 16 March, the second egg hatched, also three days before the expected hatch date. Thus, it seems like the incubation period for these birds in captivity is 37 days. The hatchling showed signs of movement, indicating it was not a stillborn. However, at 1429 hours, the male Great Pied stuck his head into the nest box and picked up the hatchling (despite attempts by the female to peck him out of the box), tossing and crushing it before offering it to the female (Figure 2E). The female accepted the offer from the male and ate its second hatchling (Figure 2F).

Three hours later, it was suspected that the female Great Pied Hornbill bit the head of the third hornbill hatchling and ate it (Figure 2G), as no egg was sighted from then onwards. Two days later, the female was observed throwing out an egg fragment.

Due to the cannibalistic events, which occurred in 2010, it was decided to pull out future eggs and artificially incubate them, then hand-rear the hornbill chicks to prevent infanticide.

The two adult hornbills were fed twice a day, once in the morning, at 0830 hours and once in the afternoon, at 1300 hours. The Great Pied Hornbill pair was fed a diet, which consists of papaya, bananas, grapes, minced meat, pinky mice and low iron hornbill pellet.

Breeding season 2011

The first egg was laid on 22 March 2011. The second egg was laid on 24 March. The hen naturally incubated the eggs for 14 days. On 4 April, a third egg was seen. Later that day, all eggs were removed from the nest box and submitted to the Breeding and Research Centre for artificial incubation. Through candling it was known that the first two eggs were fertile with active embryos, but the embryo in the second egg was weak. The third egg was fresh and still had no signs of development. The eggs were incubated in *Grumbach* incubators (Table 1), at a temperature of 36.9 - 37.2°C and at a relative humidity of 50 - 55%. The incubation period of a Great Pied Hornbill egg is about 38 - 40 days. Since the first two eggs had been incubated by the hen for 14 days, it was predicted that they should hatch in 24 - 26 days.

On 5 April, the third egg had no signs of blood vessels. The following day, a blood ring was present in the egg, indicating embryonic

death on the first stage of incubation. The first egg hatched on 14 April, and the second egg hatched on 20 April.

The two chicks were placed in *Brinsea* brooders in the nursery, which maintained a constant temperature of 37°C. Soft cotton towels were used as bedding. Before their first feeding, the two chicks were weighed. The first and second chick weighed 33.6 g and 34.4 g respectively. The chicks were weighed daily, every morning before the first feeding (Figure 3). They were fed 10 - 15% of their body weight. Their diet consisted of 60% papaya and 40% pinky mice, blanched in hot water. As they grew older, bananas, low iron softbill pellet, and mealworms were added to their diet. Nekton MSA was also added to their food to provide calcium and phosphorous, and *Duphalyte*. For the first four days, the chicks were fed seven times a day, starting from 0630 hours, each feeding spaced two hours apart. At eight days old, the bedding was changed to green matting to prevent leg splaying. Chicks were transferred to a wooden brooder once they were too big for the *Brinsea* brooders. Feeding was then reduced to five times a day, and then four times a day when the chicks were two weeks old. At Day 44, the feeding was reduced to three times a day. Both chicks had fairly constant weight gain. The first chick however gained more weight and was much heavier than the second chick. The first chick was then assumed to be male, while the smaller second chick was assumed to be female.

On 8 July, both chicks were sent to the avian hospital for endoscopy for sexing. The first chick was indeed a male, and the second chick was a female. There was a sharp decrease in the weight of the first chick from Day 62 to Day 84 (Figure 4). This decrease can be attributed to the weaning stage of the chick.

Development of the first chick (Andie):

Day 1, 14 April 2011	Chick was begging for food. It can move its head upwards and is able to gape.
Day 2, 15 April 2011	Stool of the chick was observed. No abnormalities.
Day 3, 16 April 2011	Chick is active, and begging for food.
Day 4, 17 April 2011	Maxilla is shorter than the mandible.
Day 5, 18 April 2011	Subcutaneous air sacs are observed on the neck, shoulders, legs, and abdomen. Egg tooth is present on the tip of the upper and lower beak.
Day 6, 19 April 2011	Chick begins to vocalize when it is hungry.
Day 7, 20 April 2011	Pinning in the tail observed.
Day 8, 21 April 2011	The color of the skin is yellowish. Dark colors appear on left wing. Tail feathers are beginning to emerge.
Day 9, 22 April 2011	Wing feathers started to grow. The left eye is

	beginning to open.
Day 11, 24 April 2011	Pin feathers begin to grow. Both eyes begin to open.
Day 15, 28 April 2011	Eyes are partially open.
Day 16, 29 April 2011	Appearance of dark color and black pin feathers on the chick's back.
Day 18, 1 May 2011	Egg tooth is absent on the lower mandible. Skin is darker in color.
Day 81, 3 July 2011	Chick fully fledged, able to fly. Chick is still not interested in picking up food.

Hand-rearing (chick pulled out)

In February 2012 (date unknown), the Great Pied Hornbill pair laid another egg. This time, the egg was not removed for artificial incubation so the parents could be given a chance to raise the chick by themselves. The mother diligently incubated the egg. On 10 March, the egg hatched. For the first six days, the mother was seen feeding the chick. However, on 15 March, the mother was observed to be ignoring the chick. Fearing that it would cannibalize the chick, it was decided to pull out the chick from the nest box and hand-raise it.

The chick was removed on 16 March in the afternoon, and placed in a *Brinsea* Brooder in the BRC Nursery. Upon admission, the chick weighed 115 g, and appeared healthy, although it was hungry. The chick was fed the same diet as the first two chicks. *Mazuri* Pellets and small pieces of minced meat were added to the diet, as there was a lack of supply of pinky mice. The same feeding protocol was applied to this chick. By comparing the weight gain of this chick to the first two chicks, we can conclude that it is most probably a female, as its weight gain is more similar to the weight gain of the second female chick.

When the chick was too big for the brooder on 25 April (Day 42), the chick was moved to a weaning room in the new BRC building. The room is heated with lamps to a temperature of about 29 - 32°C and humidity ranged from 50 - 70%, with the humidity being higher when the room was still slightly wet after cleaning.

Development of the third chick (Bella; Figure 5):

Day 7, 16 March 2012	Chick is observed begging for food and will gape. Stool appears normal.
Day 11, 21 March 2012	Left eye of chick is open. The right eye is partially open.
Day 15, 25 March 2012	Both eyes are fully open. Pin feathers observed on the abdomen.
Day 23, 2 April 2012	Primary and secondary pinning. Eyelashes have started growing.

Day 32, 11 April 2012	Feathers growing on the wing and tail.
Day 46, 25 April 2012	Chick is able to hop.
Day 55, 4 May 2012	Feathers growing on the back of the chick.
Day 73, 21 May 2012	Chick jumps and flaps its wings when begging for food. Chick is able to perch, but will rarely do so.
Day 76, 25 May 2012	Ventral part of the neck is covered with white feathers.

OBSERVATIONS AND DISCUSSION

Certain behaviours demonstrated by Great Pied Hornbill chicks make them somewhat of a challenge to raise. When hornbill chicks reach a certain age (around 40 days), their feeding behaviour changes (Figure 6). This was observed in all three chicks that we hand-raised. At first all of them responded well to the diet provided to them. Once they were older, they began rejecting food given to them. Sometimes the chicks would accept the food as usual, but sometimes they would reject and even regurgitate it. One must take note of this behaviour and ensure the chicks have received sufficient food. The chicks have been observed to regurgitate their food several minutes after being fed, hence one must constantly observe the chicks, especially after feeding. This behaviour is not an indication of poor health, but rather the chick being more aware of its environment and thus being pickier of the food given to it. At this stage, the chicks appeared to mainly reject fruits, and seem to only want to eat meat, but this did not occur all the time. This behaviour may suggest that hornbill chicks require more protein at this stage, or that the chick simply prefers the taste of meat.

The first and second chicks only began showing interest in feeding on their own after they were fully fledged. The third chick however, began picking up food by itself on Day 47. Previously, the chick was fed using a spoon by pouring the food into its open beak. On Day 28, the chick, rather than opening its beak and begging for food, started grabbing pieces of food from the spoon and flinging it into its throat. It was imitating the feeding behaviour of adult hornbills. Forceps were used to feed the chick instead of a spoon. A food tray with slices of banana, papaya, and large mealworms were provided to encourage the chick to eat on its own. Three days later, during feeding in the morning, the chick was observed to be paying particular attention to the mealworms on the food tray. It then proceeded to pick up the mealworms and eat them on its own. The chick learned how to pick up pieces of papaya and banana after two days. Despite being able to eat on its own, the chick was not eating enough, so it was still hand-fed small amounts of food during each feeding, which at

the time was reduced to three times a day.

In the wild, when a female Great Pied Hornbill leaves its nest, the chicks will reseal the nest with pieces of food (Tsuji and Poonswad 1996) or feces. This behaviour was also observed in the hornbill chicks. The chicks will pick up pieces of food and smash them against a surface, in the third chick's case the side of a perch provided for it.

Male Great Pied Hornbill chicks are heavier than female chicks. By the ninth day, the male chick had a higher daily weight gain than the other two chicks. Despite the difference in size and weight, the anatomical developments of the chicks are similar.

ACKNOWLEDGMENTS

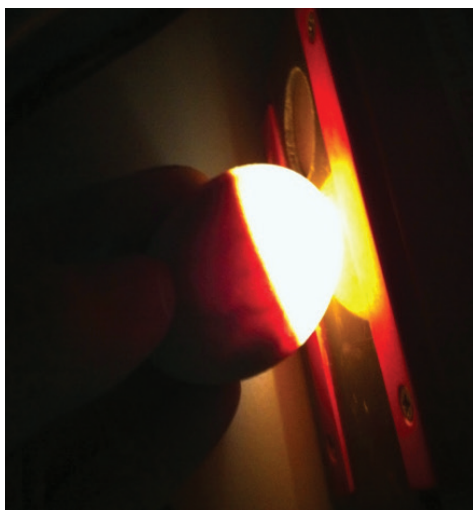
We would like to thank Muhammad Haziq Bin Rusli, Diploma in Veterinary Bioscience, School of Life Sciences and chemical technology, Ngee Ann Polytechnic for his support in hand raising the chicks; Gan Keng Tiong, for taking photographs; San Diego Zoo, for providing advice on diet and hand feeding protocol for the chicks; Avian Department for successfully breeding the Great Pied Hornbill pair; Jurong Bird Park management for supporting this project as part of the conservation program by the park.

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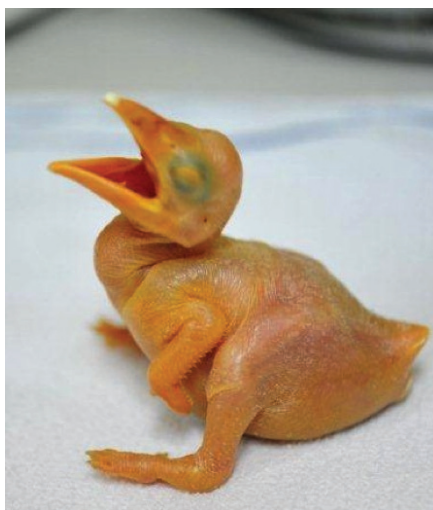
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Table 1. Product information.

Grumbach	Grumbach® incubator – artificial incubators made up of high quality synthetic material which are easy to clean and disinfect. Temperature, humidity and egg turning can all be electronically programmed to suits the species you want to incubate.
Mazuri	Mazuri® low iron pellets – these are pellets designed especially for birds that are prone to hemochromatosis or irons storage disease. The iron content of these pellets are no less than 100 ppm.
Duphalyte	Duphalyte® an infusion fluid containing amino acids, vitamin, electrolytes for extra energy.
Brinsea	Brinsea® brooders – (TLC4) - Thermal life support cabinet for brooding parrots and other altricial bird species.



A. The first Great Pied Hornbill egg at 20 days of incubation.



B. The first Great Pied Hornbill chick which was artificially incubated at Jurong Bird Park's Breeding and Research Centre, begging for food at six days old.



C. The first pair of Great Pied Hornbill chicks hatched successfully after artificial incubation. The chick on the left is 25 days old while the chick on the right is 31 days old.



D. The third Great Pied Hornbill Chick at 48 days old. The chick is almost fully feathered, except for its neck and back, where pin feathers are still growing.

Figure 1. Development of Great Pied Hornbill chicks.

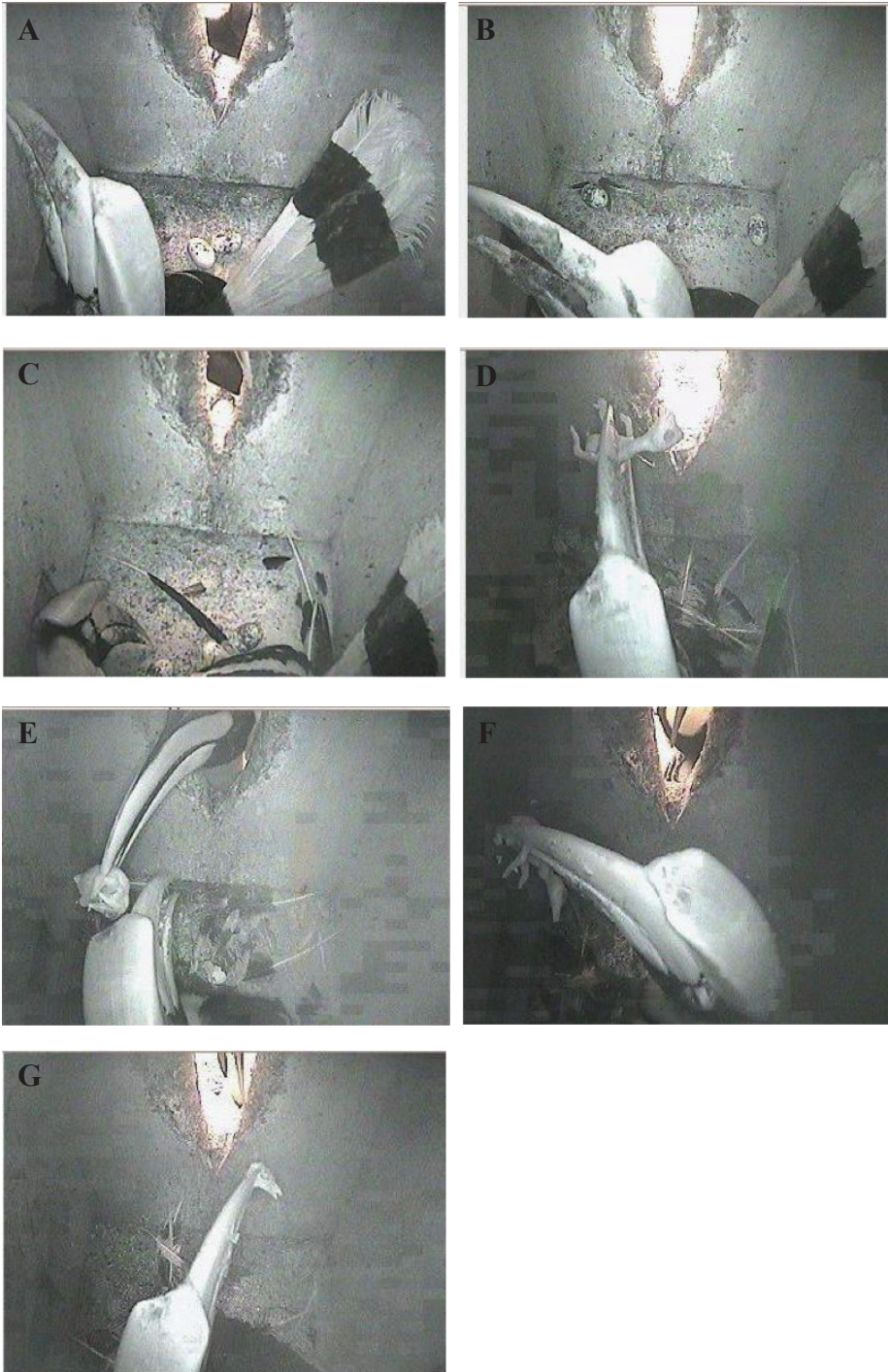


Figure 2. DVR recording inside the nest box of the Great Pied Hornbill pair, depicting the presence of three eggs and cannibalism of its chicks.

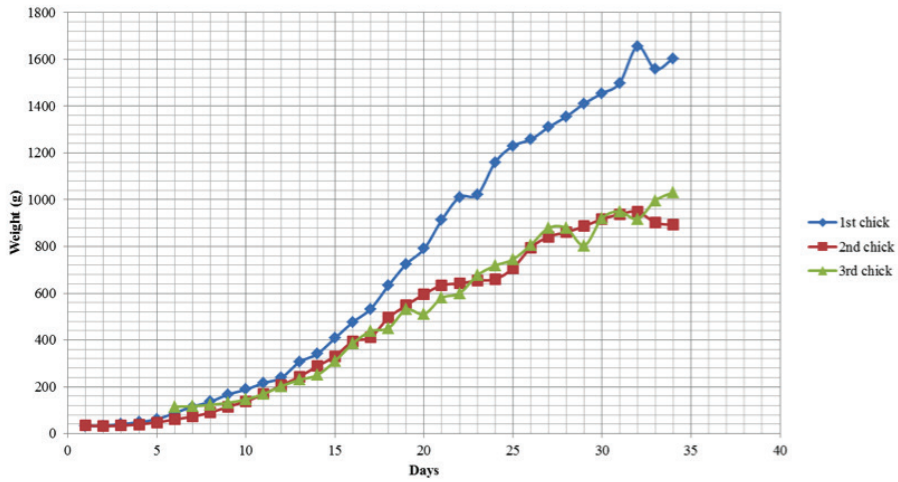


Figure 3. Comparison of weight of all Great Pied Hornbill chicks.

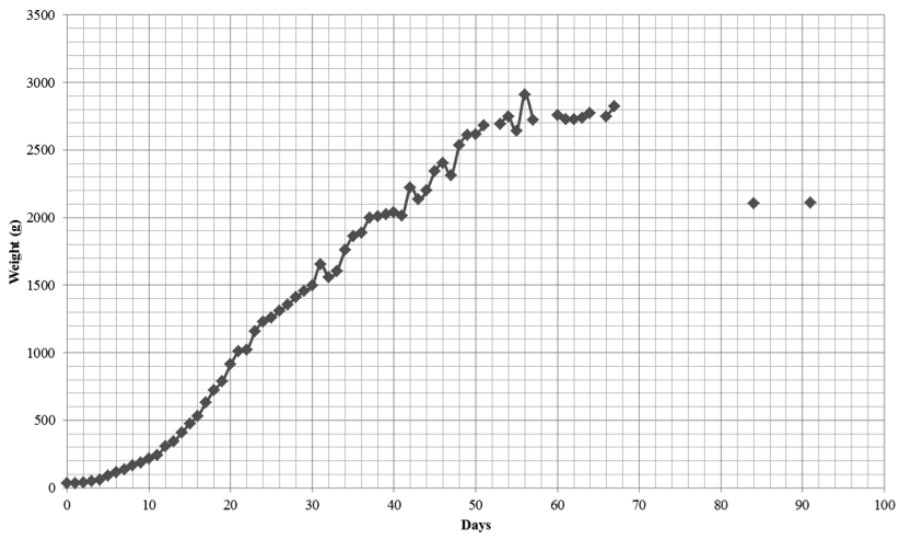


Figure 4. Weight of the first Great Pied Hornbill chick.

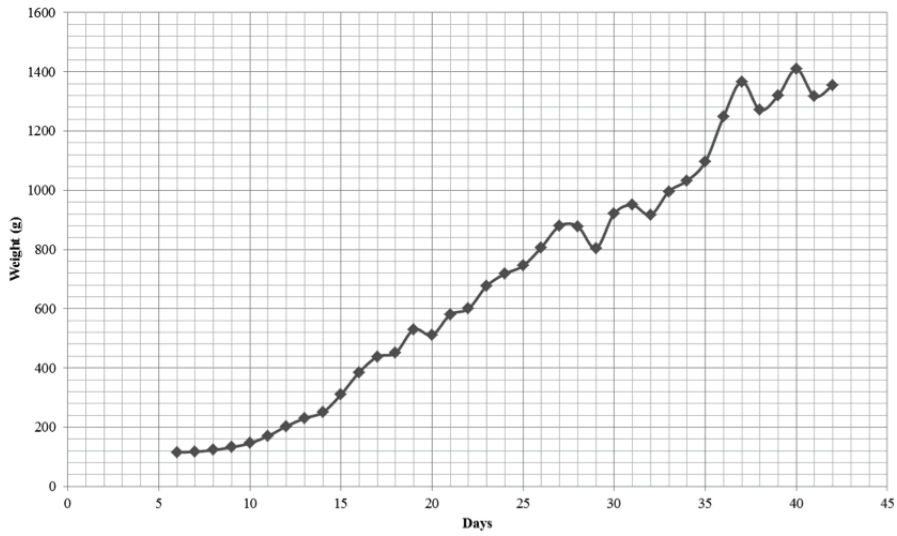


Figure 5. Weight of the third Great Pied Hornbill chick.

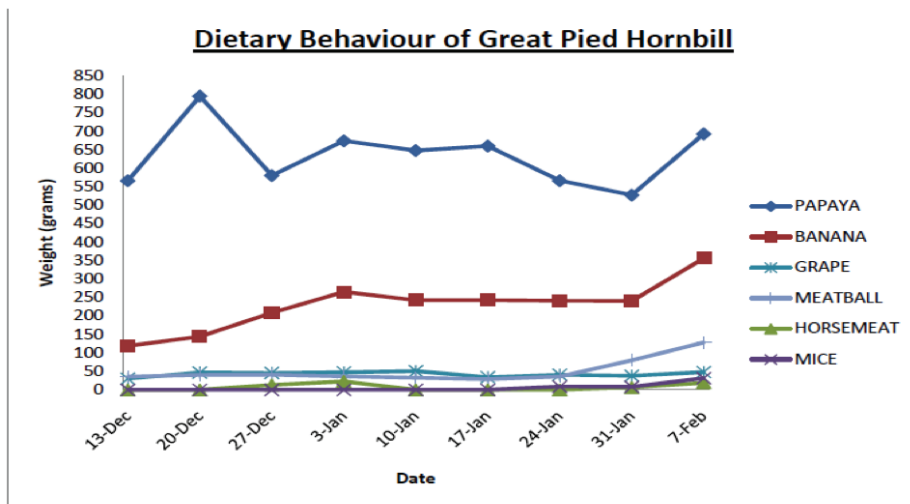


Figure 6. Dietary behaviour of Great Pied Hornbill chicks.