

# Eggs Morphometric and Growth Rates of Malaysian Captive African Penguin

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**Abstract-** Penguin is a seabird and popular attractions in zoos and aquatic parks around the world. In this study are shows the eggs morphometric of African penguin and the growth rates of African penguin chicks. Underwater World Langkawi (UWL) is the location of this study. Eggs morphometric measurements were diameter and weight. While, growth parameters measured were weight, flipper length, beak length and foot length. The relationship between weight and diameter of the eggs was tested using Pearson correlation analysis. However, the growth rate has been tested using nonlinear regression. The Pearson correlation test has shown no correlation between egg diameter and egg weight. Then, in overall, there were significantly different in growth rate for African penguin chick's weight, flipper length, beak length and foot length in UWL.

**Keywords:** eggs morphometric, growth rates, correlation, significant different.

## I. INTRODUCTION

Penguin is a seabird and an iconic figure in the world of birds, although limited their network to the Southern Hemisphere. The bird is popular attractions in zoos and aquatic parks around the world. Penguin name was believed to have originated from the Welsh in which "pen gwyn" means white head. The name was originally used for Great Auks, birds fly living in the Northern Hemisphere, before being hunted to extinction in the 19th century. Great Auks looked like the penguins, it also cannot fly [1]. All penguins in Spheniscidae family and the exact number of penguin species is the subject of dispute, with estimates ranging from 15-19 different species. There are 16 to 19 species of penguins, depending on the aspect used in classification [2, 3].

Reference [4, 5] hypothesized that the growth rate of a species is determined within narrow limits set by adult body size and the rate of development of mature functions, such as flight and thermoregulation. He identified several of influences that can result in growth rates variations within a population: variation in diet quality, quantity of food, temporal pattern of food availability, and temperature [5, 6]. Variability in these conditions may arise in relative to locality, season, habitat, weather, hatching sequence position, individual variability, brood size, egg size and composition and age and experience of the parents in the quality of parental care [5].

Few studies, particularly on penguins, especially in Malaysia, have monitored and described growth and eggs morphometric of captive penguin. This paper presents the African penguin egg morphometric and chick growth rate. Therefore, the aim of this study is to examine the eggs morphometric of African penguin and to describe the growth rate of African penguin chicks. In order to determine whether weight of eggs influence by the eggs size and to determine whether growth rates are variable. The following questions were asked: Are some morphometric parameters are more variable than others?; How much do growth rate vary?; Are bigger egg is heavier?

#### *A. Population Study*

Reference [2, 3], the African penguin (*Spheniscus demersus*) formerly known as the Black-footed penguin and as the Jackass penguin is found on the southwestern coast of Africa, living in colonies of 24 islands between Namibia Algoa Bay. The two colonies were established by penguins in the 1980s on the mainland near Cape Town at Boulders Beach near Simon's Town and Stony Point in Betty's Bay. African penguin is the only penguin species that breeds in Africa and it is found nowhere else in the world [2].

Reference [3], African penguins grew to 68-70 centimeters (cm) tall and weigh between two and five kilograms (kg). African penguin lives in colonies and have an average lifespan almost ten years. The longest lifetime was recorded are 24 years old.; however several individual have a life spent up 40 years old in aquarium settings [8].

Penguins eat squids, krill (a shrimp-like crustacean in the family Euphausiidae) and fishes. Normally, species of penguins have slightly different food preferences, which reduce competition among species. The small penguins of the Antarctic and sub-Antarctic primarily feed on krill and squids. A species found farther north tend to eat fish [9]. The main staple food in captivity is fish quit vary diets compared in the wild [10].

Newly hatched chicks the food regurgitated are very watery. The regurgitated food becomes less moist as the chick age compared to the older chicks are better in digest solid food. The demand for food from the parents should increase as the chicks growing. Therefore, food consumption by adults may increase three or four times their normal amount of this time. By three weeks of age, chicks of the smaller species are able to swallow whole fish of moderate size [11].

Penguin chicks grow quickly on a diet of regurgitated food from their parents. Occasionally the amounts of nutrition provided by their parents are inadequate to support proper growth. Parent-reared chicks can double their hatching weight in less than five days. Parent-reared chicks gain weight at a faster rate than chicks that are fed an artificial diet [12]. A comparative growth rates between hand-reared and parent-reared as reported highest weight in parent-reared after 60 days were studied [11].

Generally, two eggs are laid and incubated about 40 days. Although a single and triple-eggs clutch were reported, but are unusual depends on the eggs management practices for a given group. Both parents cooperate in incubation and chick rearing. Chicks fledged between 75-90 days. [3, 11, 13].

## **II. METHODS**

#### *A. Study Area*

The study was conducted in the year of 2011 in Underwater World Langkawi (UWL) (6°17'15.46" N and 99°43'43.54" E). This aquarium is one of the largest artificial seas and fresh water aquarium in South East Asia located on 6.2 acres of land in Pantai Chenang, Langkawi Kedah. Since beginning operations on 26<sup>th</sup> August, 1995, it has become one of the must-visit tourism destinations on the island of Langkawi and has attracted many locals and foreign tourists. It was built to raise awareness about preserving valuable aquatic life thus creating a deeper understanding and cannot be separated between man and nature. Giant tunnel along the 15 meters is the unique of UWL. There are 40 African penguins placed in Enclosure 13 (Fig. 1). The African penguins has been in a showcased since about 2005 [3, 14].

### *B. Penguin Capturing Procedure*

There were few considerations needed while capturing the penguin. First, all the penguins were gathered in one place (corner). Second, the caught penguins were held by their neck. Third, the flippers were handled carefully since there were reports on broken flippers due to mishandling [15]. Then, each of the penguins was placed into a bucket one by one. The towel was placed in the bucket to prevent any sharp edges. Thus, it is recommended that at least, two persons to handle the penguin, geared with thick gloves and eye protection are worn to prevent from pecking and struggling.

### *C. Morphometric Measurements*

Identified variations in growth rates can be done by measuring several parameters describing growth includes weight, flipper length, beak length and foot length. As for the penguin eggs morphometric, the measurement of diameter and weight of the eggs were required. It was reported that [15] that individual's weight records should be maintained over time and used for comparison when a bird appears sick. Measurements were made according to this procedure; In this study, the penguins were weighed on every month using a digital scale (DI 520, model S-4E) with precision 0.01kg [11, 16] before they were being fed in the morning Only data collected in 2011 were used in this paper.

### *D. Graph Fitting*

In this research paper, Pearson correlation analysis was employed to examine the relationship between weight and diameter of the eggs, while the analysis of growth rate of the penguins was determined by using non-linear regression.

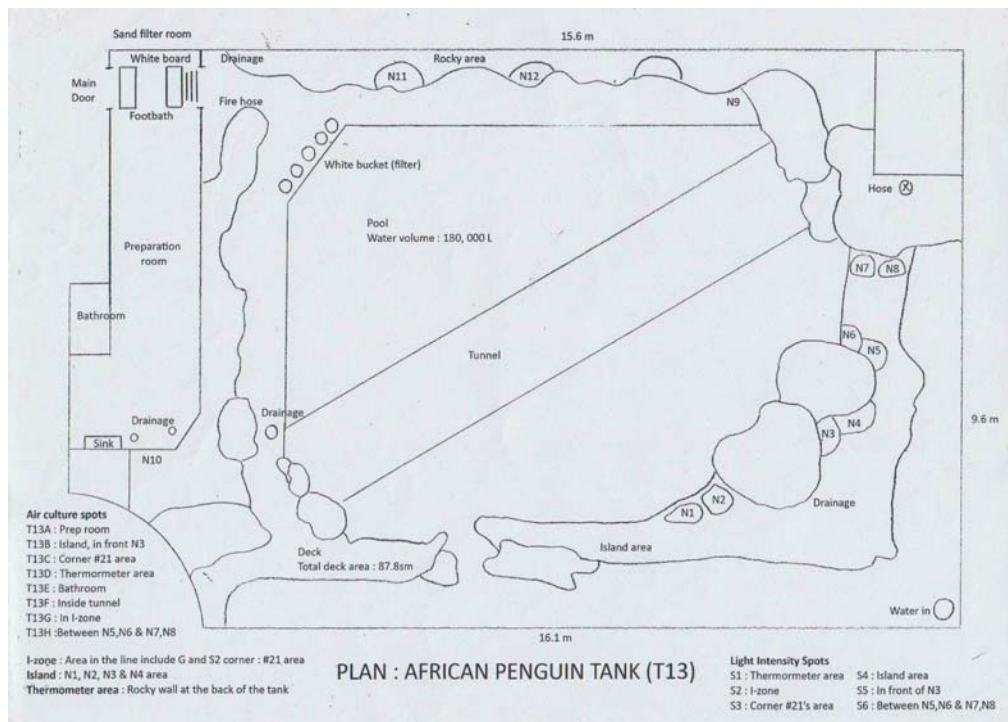


Figure 1. Floor plan of enclosure 13

### III. RESULTS AND DISCUSSION

#### A. The Eggs Morphometric

A total of 40 eggs were sampled to determine the correlation between weight and diameter of the penguin eggs. According to the Pearson analysis was indicated the egg diameter was  $36.28 \pm 3.31$ cm while the egg weight is  $96.5 \pm 17.14$ g (Fig. 2). There is no significant correlation between weight and the diameter of the eggs as shown in Figure 2.

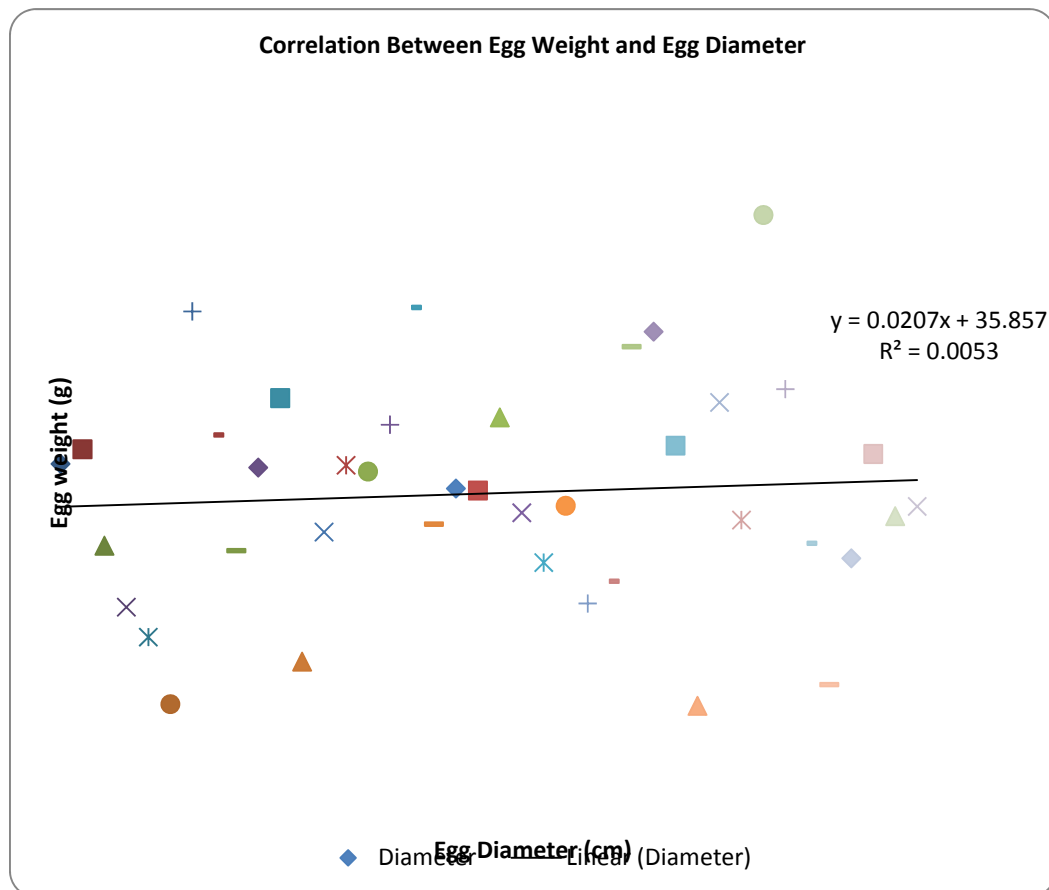


Figure 2. Correlation between diameter and weight of African penguin eggs sampled from UWL.

Reference [12, 17] discussed the large size of the eggs do not necessarily heavier. This occurs because of the weight more influenced by the thickness of egg shell, egg albumen content (egg white), vitellus (egg yolk) and air-corner cell in the egg.

### *B. Chicks Growth Rate*

The African penguin chick's growth rate has been monitored on a daily basis. The maximum weight is 2.71 g, 5.62cm is the maximum length of the beak, 21.33 cm is the maximum length of the flipper, and 12.42 cm is the maximum length of the foot. In contrast, the minimum values are usually measured on the first day of chicks hatched. The minimum values were 0.07g in weight, 1.95cm for the beak, 3.90 cm for the flipper and 3.26 cm for the foot. Overall, the average growth rate of chicks is  $1.3395 \pm 0.9232$ kg (weight),  $4.0151 \pm 1.1540$ cm (beak),  $14.4929 \pm 6.3224$ cm (flipper) and  $9.3068 \pm 3.2319$ cm (foot).

Fig. 3, 4, 5 and 6 showed the fitted quadratic nonlinear regression and the growth rate pattern for the African penguin chicks' in UWL. A total of 20 chicks were used in the analysis whereas the data were collected from November 2006 until December 2012.

The fitted line plot of nonlinear regression in Fig. 3, the maximum weight for African penguin chicks were 3.38 kg at the age of 93 days. The weight at first day was 0.073kg. Therefore, the average increased per day was 0.036kg. In Fig. 4 showed the maximum length of the beak was 8.4cm at the age of 93 days. The size of beak at first day was 1.853cm. Thus, the average of beak size increased per day was 0.07cm. Next, the graph in Fig. 5 showed the maximum length of the flipper was 23.46cm at the age of 70 days. The size of a flipper at first day was 3.885cm. This made, the average of a flipper size increased per day was 0.28cm. Lastly, in Fig. 6 showed the maximum length of foot was 20.4cm on day 79. The size of foot at first day was 3.272cm. Therefore, the average of foot size increased per day was 0.217cm.

Overall, there were significantly different in growth rate for African penguin chick's weight ( $P=0.00$ ,  $P<0.05$ ), the size of the beak ( $P=0.00$ ,  $P<0.05$ ), the size of flipper ( $P=0.00$ ,  $P<0.05$ ), and the size of the foot ( $P=0.00$ ,  $P<0.005$ ) in UWL.

Growth and survival of chicks were affected by how the investments and cares by parents among the chicks [19]. Food resources or feed is also dependent, the provisions of parental care among young individuals which affect growth and survival of chicks [20]. Weight did not differ significantly until the 14-16 days-old chicks. The difference in chick size may ease the rapid response to sudden changes in food availability by reducing litter [21].

Normally, chicks at age one to two weeks, one parent (either father or mother) stays with the chick before another one parent (father or mother) return from feeding. Food substitutes parent during the course of phase two guards' weeks. Three to seven weeks of age, chicks grow rapidly in the diet of regurgitated fish from their parents. They now have enough to stay in nest by themselves. Seven to 11 weeks of age, waterproof feathers growing in a chick's body and ready to swim in the sea or pool. Then, in the following weeks the chicks get free or fledged. Usually, every penguin has achieved their peak weight just before fl-edging. Finally, the growth performance can be increased by several factors such as nutrition of food given, the amount of food given, and the environmental (favorable nest conditions and free of infection).

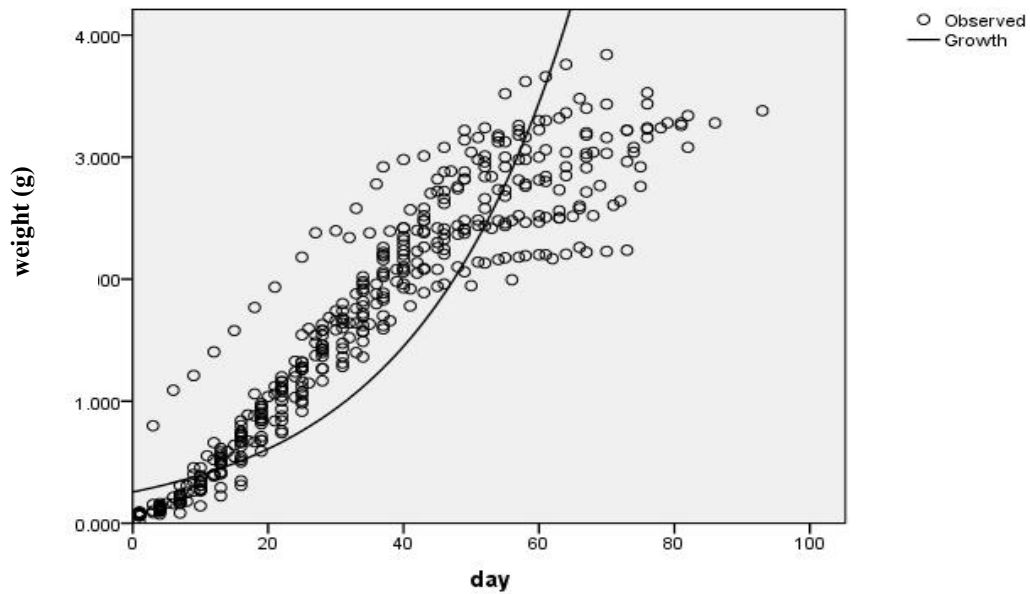


Figure 3. Change of weight (g) of African penguin chick according to non-linear regression.

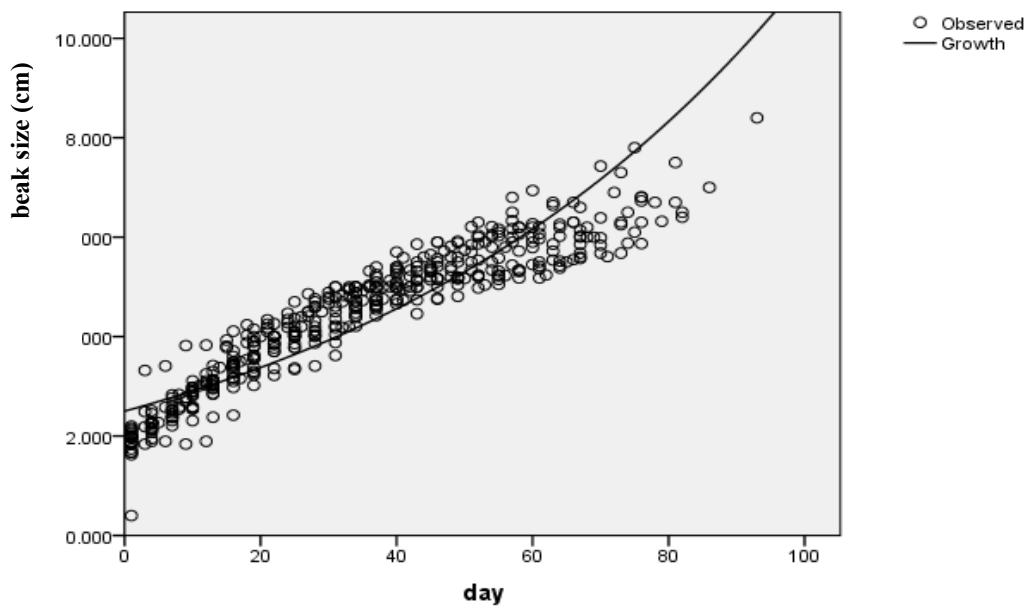


Figure 4. Change of beak size (cm) of African penguin chick according to non-linear regression.

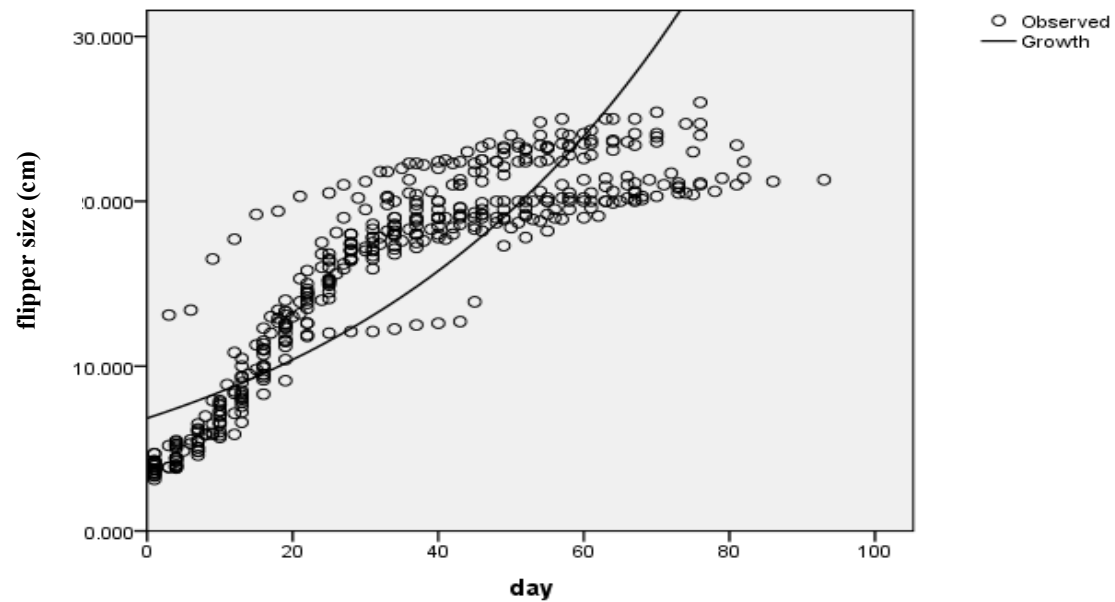


Figure 5. Change of flipper size (cm) of African penguin chick according to non-linear regression.

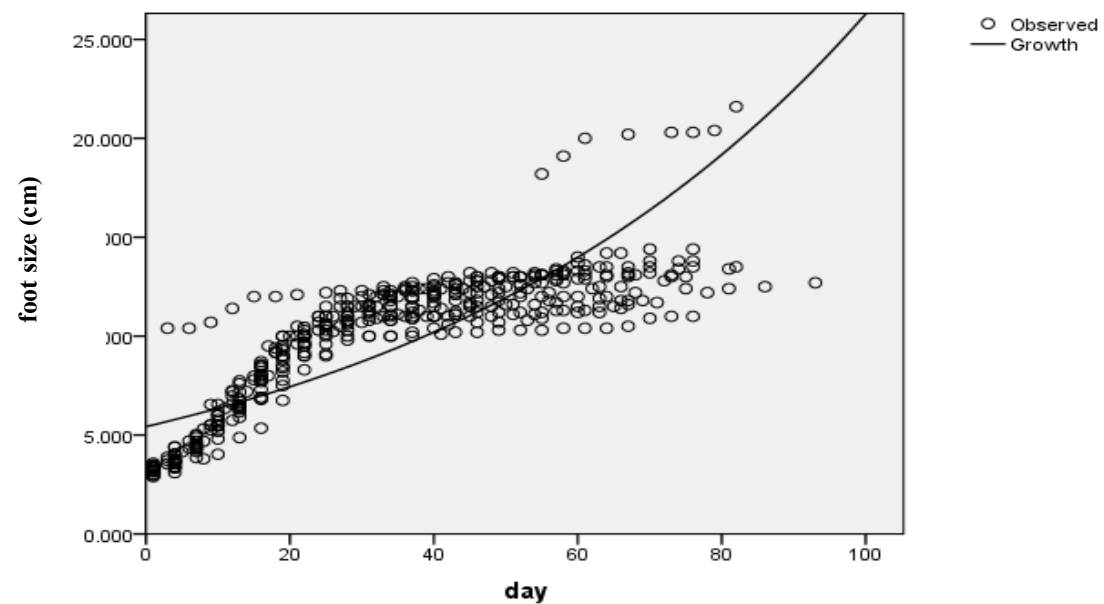


Figure 6. Change of foot size (cm) of African penguin chick according to non-linear regression.

#### IV. CONCLUSION

The large size of the eggs showed that the eggs do not necessarily heavier. The Pearson correlation test has shown no significant correlation between egg size and egg weight as shown in Appendix A.

Overall, there were significantly different in growth rate for African penguin chick's weight, flipper length, beak length and foot length in UWL as summaries in Appendix B.

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#### REFERENCES

- [1] Crawford, R. J. M., Williams, A. J., Hofmeyr, J. H., Klages, N. T. W., Randall, R. M., Cooper, J., ... & Chesselet, Y. (1995). Trends of African penguin *Spheniscus demersus* populations in the 20th century. *South African Journal of Marine Science*, 16(1), 101-118.
- [2] Smith, S.E. 2003. What is a Penguin. Conjecture Corporation. <http://www.wisegeek.com/what-is-a-penguin.htm> [1 November 2011].
- [3] M. S. Hairul and M. N. Shukor, 2016. Breeding Success of Captive African Penguin (*Spheniscus demersus*) at Langkawi Island, Peninsular Malaysia. *Journal of Biology And Nature*, Issn No. : 2395-5376 (Print), 2395-5384 (Online), Vol.: 6, Issue.: 3.
- [4] RICKLEFSR. E. 1973. Patterns of growth in birds: II Growth rate and mode of development. *Ibis* 115:177-201.
- [5] Van Heezik, Y., 1990. Patterns and variability of growth in the yellow-eyed penguin. *Condor*, pp.904-912.
- [6] R-CKLEFSR, E. 1983. Avian postnatal development, p. 1-83. In D. S. Famer, J. R. King, and K. C. Parkes [eds.], *Avian biology*. Vol. 3. Academic Press, New York.
- [7] Sparks, J., & Soper, T. (1987). *Penguins*, David and Charles Publishers Ltd.
- [8] Riesman, P. (1986). The person and the life cycle in African social life and thought. *African Studies Review*, 29(2), 71-138.
- [9] Del Hoyo, J., A. Elliot, et al. 1992. *Handbook of the Birds of the World*. Barcelona: Lynx Editions.
- [10] Cranfield M. R., Graczyk, T. K., M. R. Cranfield, et al. 1994. An ELISA for detecting anti-Plasmodium spp. Antibodies in African Black-footed Penguins (*Spheniscus demersus*). *The Journal of Parasitology*: 60-66.
- [11] Ellis, S., Branch, S., Beall, F., Zoo, A., Association, A. 2005. *Penguin Husbandry Manual*. American Zoo and Aquarium Association.
- [12] Schofield, N.A. 1991. The effects of diet and feeding regimen on growth rate of Magellanic Penguins. *Spheniscus Penguin Newsletter* 4 (2): 12-17.
- [13] Gailey-philips, J. 1978. A world survey of penguins in captivity. *International Zoo Yearbook* 18(1): 7-13.
- [14] Underwater World Langkawi Sdn Bhd. 2006. General information. <http://www.underwaterworldlangkawi.com.my/about.html> [17 July 2012].
- [15] Schneider, S. 2003. The mystical and the spiritual in the large group. *The large group revisited: the herd, primal horde, crowds and masses* 25: 73.
- [16] Reilly, P. 1994. *Penguins of the World*. Oxford University Press, New York, NY(USA). 1994.
- [17] Solomon, S. 1987. Egg Shell Pigmentation.
- [18] Hairul, M.S. and Anuar, S., 2014. Developmental Stages of Southern River Terrapin (*Batagur affinis*) In *Wildlife Conservation Center Bota Kanan*, Perak, Malaysia. *Journal of Wildlife and Parks*, 28, pp.1-7.
- [19] Smith, C.C., Fretwell, S.D., 1974. The optimal balance between size and number of spring. *Am. Nat.* 108, 499-506.
- [20] Brockelman, W.K. 1975. Competition the fitness of offspring and optimal clutch size, *am, Natural*. 109: 677-699.
- [21] Ricklefs, R. E. 1965. Brood reduction in the Curve-billed Thrasher. *Condor* 67: 505-510



Appendix A. The diameter and weight of African penguin eggs sampled at UWL.

<b>Parameter</b>	<b>Average</b>	<b>St. Deviation</b>	<b>Pearson correlation</b>
Egg Diameter	36.28	3.31	0.9897
Egg weight	96.5	17.14	

Appendix B. Average weight, beak, flipper and foot length of african penguin at UWL.

<b>Standard</b>	<b>Weight (kg)</b>	<b>Beak (cm)</b>	<b>Flipper (cm)</b>	<b>Foot (cm)</b>
average	1.3395±0.9232	4.0151±1.1540	14.4929±6.3224	9.3068±3.2319
Max	2.711	5.621	21.333	12.427
Min	0.074	1.947	3.896	3.26