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Conservation of maleo bird (*Macrocephalon maleo*) through egg hatching modification and ex situ management

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ABSTRACT

*Rusiyantono Y, Tanari M, Mumu MI (2011) Conservation of maleo bird (*Macrocephalon maleo*) through egg hatching modification and ex situ management. Biodiversitas 12: 171-176.* Over exploitation of maleo bird eggs has become the main problem. In addition, habitat demolition and fragmentation have also caused decrease in maleo bird population. This research aimed to know the effectiveness of hatching pattern to produce maleo breeding, studying breeding pattern of maleo bird through hatching approaches of feed quality and temperature adjustment, and studying maleo bird respond towards caring pattern adjustment by measuring plasticity value. There were two phases in this research. The first phase was hatching by using modified incubator. The other one was the caring of the breeding from the result of hatching through feed pattern management using protein and energy balancing. The results of the research indicated that the hatching success was 65%; however, life endurance of the birds from birth to one month of age was only 40%. Their growth showed sufficiently high increase after passing critical period in their body-weight based on feeding pattern containing 21% of protein that was 64.93 g and 62.59 g for maleo in Lore Lindu National Park (LLNP) and Bangkiriang Wildlife Reserve (BWR), respectively. Their monthly body-weight increase was 33.06 g in average of feeding pattern containing 13% of protein for LLNP maleo birds and 36.99 g for the maleo in BWR. It was found that feeding pattern containing higher content of protein (21%) promoted significant increase in the body-weight of maleo birds. Feeding such birds with high protein content feed along with sufficient energy triggered their growth speed. Based on the findings, it was concluded that maleo birds could be preserved by way of hatching, while the birds could be fed with feed containing high protein and energy in order to accelerate their growth after hatching.

Key words: maleo, conservation, hatching, daily gain, feed conversion.

INTRODUCTION

Maleo bird (*Macrocephalon maleo* Sal. Muller 1846) is a kind of endemic wild animal of Sulawesi island. Its existence is protected by the government regulation No. 7 Year 1999 dated 27 January 1999 concerning the preservation of Flora and Fauna Species (Noerdjito and Maryanto 2001). In the efforts of Maleo conservation, problems often exist in terns of egg utilization either for individual, ceremonial, or social purposes of the local community which, in fact, ignores the concepts of maleo bird conservation. Over exploitation of maleo bird eggs has become the main problem. In addition, habitat demolition and fragmentation have also caused decrease in maleo bird population. This fact has made that maleo bird has recorded in the *IUCN Red Data Book* (International Union for Conservation of Nature and Natural Resources) categorized as *endangered* (MacKinnon 1981; Argeloo 1991; Gunawan 1995).

Various efforts have been taken for preserving maleo from the extinction, such as breeding them in their original habitat. However this effort does not bring a good result. Another way to preserve maleo is through biotechnological reproduction approach. Until recently there has been very little information on maleo breeding. The incubation period is around 62-85 days, depends on the soil temperature, and with the best temperature of maleo eggs around 32-35°C (Dekker and Brom 1990). The average temperature of maleo eggs to hatch was around 33-35°C with average of soil humidity of 96.5% in the morning, 70.7% in the afternoon, and 89.5% at night (Wiriosoepartho 1980). In the efforts of increasing the reproduction efficiency, the researchers bred maleo eggs in a controlled temperature and humidity incubator. Naturally, the mating of maleo has never been spectated in the hatchery. This means that the mating was done in other place in the forest. It is a monogamy animal. Male and female maleo are never separated more than a few meters when feeding, hatching, and sleeping on big horizontal tree branches (Jones et al. 1995). Thus, in order to increase their mating intensity, they were put in one controlled pen. For the time being, technology of hatching maleo bird eggs and controlled breeding pattern are promising for conservation of this endangered species.

MATERIALS AND METHODS

Materials

This Research has been done in different site and the egg collected from two places namely: (i) Lore Lindu National Park (LLNP) which is located in the center of

Sulawesi Island, (ii) Bangkiriang Wildlife Reserve (BWR), which is located in the coastal area, is passed through by a provincial street connecting Luwuk to an areas surrounding the conservation area in Luwuk District, 600 km to the east of Palu, Central Sulawesi, Indonesia. This research started from July until November 2005

Procedures

Egg collection and selection

The maleo bird eggs were collected from two locations which have different topography, namely: (i) Lore Lindu National Park which is located in the center of Sulawesi Island. The location has little impact of sea breeze where the maleo bird egg collection took place, especially sector of Saluki, Tuwa village that is classified as type A and B according to the climate type of *Smith Ferguson* and was surrounded by steep hills and has an altitude of 235-305 m asl. and steep stream flow. (ii) Bangkiriang Wildlife Reserve, which is located in the coastal area, is passed through by a provincial street connecting Luwuk to an areas surrounding the conservation area in Luwuk District, 600 km to the east of Palu City, Central Sulawesi.

The period collection of Maleo bird eggs is a month. Collected eggs were then selected on the basis of performance and intactness of eggshell. The intact and clean eggshell was put in next selection for morphometrical measurement.

Egg index measurement

In order to get egg index data, it should be done morphometrically by looking on egg shape, egg weight (gr) (measured by using Ohaus capacity scale 2610 g with *triple beam balance*), egg length (mm), and egg width (mm) which measured using caliper with carefulness 0.05 mm.

Hatching method

The selected maleo eggs further hatched using incubator by temperature 33.5-34.4°C or the average 34.061±0.187°C with relative humidity = RH is around 69-74% or the average 70.875±1.431. The model of incubator used is made of wood and play-wood by 130 cm length and 70 cm height with the capacity of 64 eggs. The machine equipped with micro-switch thermostat, thermohygrometer, 4 electric light bulbs (60 watt), egg-telescope, water container for humidity arrangement and a room with the same size as the machine used as the place for the breeding newly hatched maleo.

Incubation period and hatchability

The incubation period was counted from the time when eggs were put into incubator until they hatched. The eggs were given code based on their habitats. To know the affectivity of egg-hatching, it needs to measure the hatchability formula proposed by Effendi (1974) as follows:

$$S\ (\%) = Nt/No \times 100\%$$

S = hatchability
Nt = hatching eggs
No = eggs observed

The breeding pattern of maleo

The hatching maleo was put into a scaffolding individual stall equipped with feed hopper and water container as well as thermostat. The feeding used was commercial bird feed in the growth phase for day old chick with crude protein (CP) content 21%, Metabolic Energy (ME) 3000 kkal kg and CP content 13 %. ME 3000 kkal kg. Feed and water were given according to *ad-libitum*. Water given were added was vitamin “anti-stress” (1mg/100 mL)

Feed intake

Feed intake was counted amount of feed intake in grams per month and the total intake of maleo birds for five months breeding.

Daily gain

Daily gain was counted monthly live weight gain of maleo in five months. To know daily gain through measuring live weight of maleo by formula as follows:

Live weight at 7^{th} of week-live weight at 1^{st}

Feed conversion

Feed intake and its efficient utilization is one of the major concerns in poultry as feed cost is one of the highest components of total cost of production (Rosario et.al. 2007). The value of feed conversion counted by feed intake in gram divides live weight of maleo.

Phenotypic plasticity

The animal performance is influenced by genotype, environment and interaction between genotype and environment has either positive or negative impacts toward animal performance. The number of phenotypic plasticity is calculated base on the characteristics difference of two different environments

RESULTS AND DISCUSSION

Index of eggs

Eggs are available in different shapes. These shapes can be differentiated using a shape index (Altuntas and Şekeroğlu 2008). Alkan et al. (2008) stated that egg shape index was predictable with better accuracy from egg weight, egg width and length. In comparison to other poultry species, a study of determining the effect of shape index and egg weight of quail (*Coturnix coturnix japonica*) eggs on the property of hatchability, hatchling weight and weekly body weight gain has been performed by Copur et al. (2010). They concluded that 13 g hatching egg weight group in quail is the appropriate optimal weight in terms of hatchability of fertile eggs and growing period performances, although those properties do not change according to variations in shape index. Based on the collected eggs from the field, only 45% could be proceed to hatching process. The average weight of eggs applied in this research was between 160-226 g while the index of the eggs weight was about54.0-63.0 (average 59.0). The eggs which were out of standard might have been caused by factors such as nature (rain) and transportation.

Table 1. Morphometric of maleo eggs were collected at different two habitats

Morphometric	Habitat	
	LLNP	BWR
	n = 63	n = 42
Weight (g)	208.10^{a} ± 12.39	210.39 ^{a}± 10.74
Length (cm)	10.30^{a} ± 0.34	10.28 ^{a}± 0.25
Wide (cm)	6.11^{a} ± 0.18	6.11^{a} ± 0.11
Indeks (L/P)	59.36 ± 2.63	59.47 ± 1.83

Note: Same letter in the same row between morphometric measurements of LLNP and BWR showed no significant differences (P>0.05)

The measurement results in LLNP egg morphometric and BWR, no statistically significant difference, so the size of eggs in both places (LLNP and BWR), is no different (Table 1). According to Sumangando (2002) obtain egg weight range 110-250 g, length 9.7 to 10.7 cm long and 5.7 to 6.2 cm wide. This variation is very possible because of differences in location, availability of food, as well as differences in parent maleo season as place for laying eggs. Meanwhile, Farooq et al. (2001) indicated that egg weight was easily predictable from egg length and width. Information on egg weight along with egg width and length will further open the domain for trying out various prediction equations in order to predict eggshell weight and shell thickness (Khurshid et al. 2003). The weight and size of eggs obtained from LLNP and BWR also vary, the weight and size of eggs is likely due to the laying of maleo age varied.

Hatching

Hatchability was obtained at incubator 70% and 65% for eggs collected from TNL and BWR respectively. An average obtained hatchability of 67.5%. The result is relatively high compared with semi-natural hatchery in LLNP and BWR. The humidity below 40% and above 80% will reduce hatchability of chicken eggs (Mansjoer 1985). Embryos that died probably caused by the inverted position of the laying of eggs in an incubator, and eggs which fall when other eggs hatched. Low hatchability may also be influenced by the distance between hatchery process and location of egg collected to far and also the influence of the season, which at the time of egg collection to coincide with the rainy season, so the eggs and water intruding happen decay.

Tanari et al. (2008) suggests that there are two factors that influence the process of embryogenesis and hatching of biological factors and environmental factors. For comparison on turtle nesting, they are also making their nests in sand; incubate their eggs by relying on the sand temperature of 29ºC. If the temperature is too hot, the young turtles can be killed so that turtles have not hatched.

Compared with hatchability obtained in semi-natural hatchery, the hatchery using remote incubator for hatching eggs are promising Maleo. Hatching which is done in situ gives not good results because of several weaknesses, among others, the difficulty of control of temperature and humidity due to seasonal changes frequently. Thus hatching using the incubator is the best solution to further increase egg hatchability maleo. Overall of hatching process can be seen at Figure 1. The result of even this contribution to help solve problems that is less successful hatching in both natural habitats and in semi-natural hatchery.

Observation was done on a daily basis in order to see the egg condition. Duration required to process outside of the Maleo from shell was approximately 3 hours.

Maleo bird breeding

A critical period of maleo to grow is up to one month old and this period could be seen as a high rate of death of young maleo which can reach up to 60%. Such a condition needs further research in order to know the most determining factors of the birds to be survived (Dekker 1990). It was found that monthly live weight gain of maelo using 21% of protein as a feeding pattern was 64.93 g and 62.59 g in average for maleo from Lore Lindu National Park and Bangkiriang Wildlife Reserve respectively. In feeding pattern with protein content of 13%, their monthly live weight gain development was 33.06 g in average for the birds from LLNP and 36.99 from BWR. Based on those results, feeding with higher protein content (21%) can lead the birds gained more weight. Feeding with high protein content along with sufficient energy would optimize maleo growth speed.

Feed intake

The average of feed intake in grams per month and total intake of maleo birds for five months breeding can be found in Table 1. An intake of maleo birds of LLNP and of BWR for five months breeding showed an increase of their intake, either in the level of 21% or 13% protein. The amount of intake in the level of 13% protein was relatively higher than 21%. Low intake of 21% protein might be caused by the sufficient need of protein for the birds, reported that the amount of protein used for growing native chicken and its hybrid with Rhode Island Red is determined by protein content in feed intake.

Table 2. Average of intake (g/bird) per moth for maleo birds within three months breeding

Habitat	Protein intake (%)	Month			Total
		1	2	3	
LLNP	21	540.00	578.33	615.00	577.78
	13	583.33	610.00	635.00	609.44
BWR	21	531.67	561.67	601.67	565.00
	13	580.00	611.67	655.00	615.56

An amount of 21% protein intake was relatively higher than of the level of 13% for the birds to both LLNP and BWR. The amount of protein intake was determined by a quality and sufficiency intakes as well as organ capacity *(intestinum)*. A quality and sufficiency intakes lead to determine a genetic potential optimalization owned by an animal. Behavioral performance depends on genes owned by an animal, but supporting environmental condition is needed to give opportunity for a total characteristic performance (Hardjosubroto 1994). Furthermore, Martojo (1992) stated that environment directly influences the phenotype of an animal through feed, diseases, managements, but not the genotype. It is also described that possible influence to genotype may indirectly happen by way of natural or artificial selection.

Figure 1. Hatching process of maleo bird in captivity

Steps	Activities	Figure
1	Egg which is newly hatched begins cracking its eggshell because of active pressure from both legs of egg pointed shape that is predicted about one and third on the pointed shape of the egg. The process can be indicated with shell cracking where after that it will be followed by producing a dark red liquid and then became clear red. Such active pressure repeatedly appears until forming a big crack on the egg. Such each pressure followed by a breaking phase about 15 minutes.	A,B
2	When the egg hole became bigger until the bottom of the egg, such active pressure became loss so that leg and claw have a space to help for making the hole bigger.	C
3	The breaking phase at each pressure is also same when breaking egg beginning. The phase of breaking became shorter in minutes when a young maleo wants to leave the eggshell.	D
4	The young maleo which is still in the eggshell has already an open eye or it may be called semi artificial.	F
5	A free young maleo from the eggshell is directly out of incubator where physical condition of this bird has already strong with its fully feather as well as strong leg and claw. Unfortunately, this young maelo needs more time to take a rest in order to be recovered and has still no power to avoid attack from surrounded.	G
6	The activities of young maleo until the age of 1 week have shown no powerful movement if at just a hand in distance, but avoiding instinct have been done by the bird in a way of running or jumping with a great distance about 1 m. This condition can lead the young maleo will be threatened by other predators at its habitat especially when the bird out of its natural hatching.	H
7	At age of 2 weeks, the young maleo can do low fly (about 2 m) with about 3 m in distance.	I

Daily gain

The average of monthly live weight gain of maleo in three months can be found in Table 2. The birds gained weight every month either in the level of 21% or 13% of protein. However, the body-weight showed a better result in the intake of 21% protein than that of 13% protein. In terms of gain within five months, the birds of LLNP showed a better result of weight gain than the birds of BWR when fed in the level of 21% protein. Unlike when fed in the level of 13% protein, the birds from BWR showed a better result of weight gain than the ones from LLNP.

Table 2. An average of body-weight (g/bird) of maleo in monthly basis weighing

Habitat	Protein intake (%)	Month			Average
		1	2	3	
LLNP	21	243.59	306.41	377.07	309.02
	13	192.66	225.24	257.06	224.98
BWR	21	209.40	277.31	342.59	276.43
	13	186.40	226.58	265.91	225.40

The average increase of body-weight can be found in Table 3. It showed that when the birds fed 13% of protein, there was a decrease in weight gain of LLNP birds, while there was an increase in weight gain of BWR birds. However, in the level of 21% protein, birds of LLNP showed a better increase in weight gain.

Feed intake does not show linear relation with gain. Every livestock has different capability in feed conversion (Sidadolog and Yuwanta 2000). This thing, from genetic aspect, can be understood that differences happened were caused by extreme environment.

Table 3. Average of body-weight gain (in gram) of maleo in monthly basis

Habitat	Protein intake (%)	Month			Average
		1	2	3	
LLNP	21	61.30	62.82	70.67	64.93
	13	34.77	32.58	31.82	33.06
BWR	21	54.57	67.92	65.28	62.59
	13	31.50	40.13	39.33	36.99

If two or more individuals develop and grow in the same environment and show different phenotype, it can be concluded that the two individuals have different genotype. In contrast, although there are two or more individuals having the same genotype but develop in different environment, their phenotype may be different (Schlichting and Levin 1984). The domesticated maleo are still showing body weight gain so that they can be adapted out of their original habitat.

Feed conversion

A value of feed conversion of 21% protein tended to be fluctuated for both resource places (LLNP and BWR). This situation was caused by the amount of intake which is not always linear with the body-weight gain of maleo.

Table 4. Average of feed conversion for maleo

Habitat	Protein intake (%)	Month			Total
		1	2	3	
LLNP	21	8.81	9.21	8.70	8.91
	13	16.78	18.72	19.96	18.48
BWR	21	9.74	8.27	9.22	9.08
	13	18.41	15.24	16.65	16.77

Feed conversion value of breeding native of 20-22 months old chicken was 11.17 to 18.17. Feed conversion of 1 year old chicken was 16.23 (Olomu and Offiong 1980). By providing 21% protein level, the birds of LLNP were more efficient than the ones of BWR. On the contrary, giving 13% protein level, the birds of BWR were more efficient than the ones of LLNP. This showed that maleo birds of BWR were easier to grow up than the ones of LLNP.

Body-weight plasticity

Phenotypic plasticity means function of phenotypic value shown by livestock in different environment. Kolmodin et al.,(2002) states that phenotypic plasticity does not belong a genotype, but specific for others. Plasticity phenotype value of body-weight of maleo from LLNP was relatively bigger than those of BWR. This showed that the birds from LLNP decreased in gain relatively bigger than those from BWR, 31.87 g and 25.60 g respectively. Gene plasticity of maleo from LLNP was more influential to body-weight for more plasticity, while the gene plasticity of birds from BWR was able to control body-weight decrease.

In one hand, habitat condition of LLNP which provides abundant feed caused maleo from LLNP could not survive in an environment with limited feed stock, on the other hand, maleo from BWR could survive in an environment with bad feedstock. This showed that there was difference in phenotypic plasticity between birds from LLNP and those from BWR.

CONCLUSION

Weight of eggs did not influence egg hatchability, while egg index has a bigger chance to be hatching which was around 54-63. Feeding with high level of protein and energy increased body-weight of maleo. Maleo birds are able to adapt to a new environment or their external habitat.

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