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ANTLER'S GROWTH OF THE ENDANGERED AND ENDEMIC BAWEAN DEER (*Axis kuhlii* Müller & Schlegel, 1842)

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Abstract

*Bawean deer (*Axis kuhlii*) is an endangered Indonesian deer that is quite unique since its habitat is isolated and the species is endemic to the Bawean Island. Data on its biology is very limited, especially those related to antler's growth. Monitoring the antler's growth from the post weaning age (3-4 months) to 22 months old showed that, this process was related to the animal's reproductive physiology, starting at the age of six months, when the testes entered the scrotum, and a rapid body growth occured. At the age of 21 months, the animal had its first full hard antler's. The stag had its longest period of hard antler's at least for more than eight months. There seemed to be a close relation between the body growth cycles and the antler's growth. Hair molting lasted for 25-40 days. These results indicated that the period of physiological change in relation to antler's growth and some reproductive activities in the Bawean deer were within the cycle of other temperate and tropical deer species.*

Key words: Bawean deer, *Axis kuhlii*, antler's growth, molting.

Introduction

Bawean deer (*Axis kuhlii*) is a small deer endemic to the Bawean Island (5°46'S 112°40'E), 150 km from the mainland Java Island, Indonesia. The small natural habitat (200 km^2) makes the Bawean deer as the only isolated deer in the world (Blouch & Atmosoedirdjo, 1987). Taxonomically, the status of this deer is still in continuous debate concerning its very specific morphological characteristics (Bemmel, 1944, 1953).

Since 1979 part of the Bawean Island has been declared as Wildlife Reserve (3,831,6 ha) and Natural Reserve (725 ha), for the protection of Bawean deer, whereas the deer it self in Indonesia has been protected since 1970. Population census conducted in 1996/1997 indicated that the wild population was approximately 400 heads, and in captivity reaching around 200–250 heads that is spread out throughout zoos, safari parks and individual breeders (Semiadi, unpublished data). In 1979 the wild population was reported to be around 200–400 heads (Blouch & Atmosoedirdjo, 1987). Due to the small population number, the International Union for Conservation of Nature and Natural Resources (IUCN) has listed Bawean deer in the threatened category (Baillie & Groombridge, 1996).

Observations on captive Bawean deer show that this animal is easy to reproduce with minimum health and management problems (Blouch & Atmosoedirdjo, 1978; Bambang, pers. comm.). Though the number of captive Bawean deers increases significantly, its biological information remains less understood. A study on antler's growth cycle indicates that it can be used as an indicator of reproductive physiology, and this has been proved with temperate and other tropical deer (Fennessy & Suttie, 1985; Semiadi *et al.*, 1994). In order to improve our understanding on its reproductive biology, monitoring was conducted on the antler's growth cycle in captive Bawean deers, starting from post weaning to mature age, and some aspects related to antler's development.

Materials and Methods

Observation on the antler's growth cycle of Bawean deer was carried out on two groups of captive Bawean deer; namely Bogor Group (BG) and Grati Group (GT). Genetically, the two groups came from the same captive breeding source i.e. the Surabaya Zoo in East Java. The BG consisted of six post-weaning age (3 stags and 3 hinds), aged between 3–4 months, were placed in individual cages (2.5 m^2). In GT there were 18 deer (5 adult stags, 8 adult hinds and 5 mixed sex young deer) and they were all located in a captivity compound of 110 m^2. Feed and drinking water were given ad-libitum, BG deer were fed with a mixture formula consisted of 30% dry elephant grass (*Panicum maximum*) and 70% commercial beef fattening pellet, and for GT they were fed with fresh native grass, chopped elephant grass and once in a while wet rice bran.

The observation on antler's growth in BG started after the weaning age until 22 months old, while in GT the observation was executed to all mature stags and lasted for 10 months. Antler's were categorized as in hard condition when the velvet from either side of antler's was noticed to shed. Whereas antler's casting was identified when one of the hard antler's had dropped. During observation, the body weight changes of BG, conducted by hand straining, was also monitored when it was possible. This was due to its flighty and nervous type animals.

Morphometry of adult Bawean deer antler's was conducted from museum specimens deposited at Division of Zoology, Research Centre for Biology - Indonesian Institute for Sciences (LIPI) in Cibinong and from one antler that was owned by a local person in Bawean Island. The maturity of deer skull was indicated by the unification of cranial sutures and the normality of antler's growth was shown by the present of double branch antler's. The measurement of antler's length was conducted using a polypropylene ribbon tape with 0.10 mm precision. Antler's diameter was measured using digital micro caliper (Shimadzu, Japan) with 0.01 mm precision, and the angle of antler's branches was measured using metal archers completed with an angle pointer (Shinwa, Japan). Antler's beam length was measured at the

lateral part of antler's body starting from the base of coronet right through to the main antler's tip. The length of first tine was measured at the lateral part starting from the base of the tine through to the first tine tip. The length of the second tine was measured at the lateral part starting from the base of the tine to the second tine tip. Beam diameter was measured at the center of the antler's, between coronet and the base of the second tine. Main antler's beam span was measured between both main antler's tips, antler's second tine span was measured between second antler's branch tips, antler's first tine span is measured between both first branch antler's tips. The angle of the antler's first branch was measured between the body of the main beam and the first branch, and the angle of the second branch was measured between the main antler's body and the second branch.

Results and Discussion

The early growth of the antler's was indicated by the appearance of a round mark of hairs on its head where pedicle would grow. This event was more obvious at the age of five months, though it can be seen as early as four months old. It takes about five months from the appearance of its round mark until the full growth of pedicle and continuous to the growth of clean hard spike (Table 1). Pedicles started to grow at six months of age for 54.7 days and velvet spike was noticed 1.5 months later, which took 72.3 days to fully grown (Table 2). As the pedicles started to grow, based on the palpation results of two stags, it showed that at that time (six months old) testes had entered the scrotum. At the age of 21 months the deer had reached full hard antler's condition indicated with the form of two branches. As stags reached their fully grown hard antler's, the length of time in hard conditions was noticed to be in their individual characteristics. One stag had in hard antler's for more then eight months when the study was terminated. The size of the first year spike was relatively short, only 42.3 – 51.4 mm in length with rather spherical shape. Cast time between both antler's in hard spike and full hard antler's was only one day apart.

Table 1. Antler's development of captive Bawean deer (n min.= 1, max.=4).

Age (month)	Stage of development
6.0	A round mark of hairs on top of the head, which pedicle would grow, was noticed. Testicles had dropped into scrotum
6.0 - 7.5	Pedicles start to emerge (± 5-10 mm height)
7.5 - 9.0	Velvet spikes start to grow
12.0	Velvet spikes shaded
10.5 - 12.5	Hard spikes antlers
16.0 - 18.0	Hard antlers cast
21.0	Full hard antlers

Table 2. Antler's growth (days) in captive Bawean deer (n min=1, max=3).

	Days	Mean	SD
Pedicles growth	38; 56; 70	54.7	13.1
Velvet spike growth	68; 70; 79	72.3	4.78
Length of hard spiker	151; 181	166	15
Velvet antlers growth in second year	69	69	
Velvet antlers growth in adult stags	76; 136	106	30
Length of full hard antlers	88; 120; 243[#)]	1041)	16

[#] still in hard antler's when the study ends. [1)] from two values exclude [#)] animal

Table 3. Antler's cycle in adult captive Bawean deer.

Stag	Month									
	O	N	D	J	F	M	A	M	J	J
1	h	h	h	h	h	h	h	h	hv	v
2	h	h	h	hv	v	v	vh	h	h	hv
3	vh	h	h	h	h	h	h	h	h	h
4	vh	h	h	h	h	h	h	h	h	h
9		v	v	v	v	v	h	v	v	v

Note: v= velvet, h= hard antler's.

From three adult stages of GT, there was a tendency of relation between the length of velvet growth and body weight. Stag with the lightest live weight (13 kg) took 136 days for velvet to grow and the moderate live weight (19 kg) took slightly shorter time to only 76 days, whereas the hard antler's period lasted for 120 and 88 days respectively. In the heaviest category (33 kg) stag in the hard antler's condition lasted for 243 days and it went on when the observation was terminated. Table 3 shows that the hard antler's condition for mature stags tends to be individualistic, resulting stags in hard antler's condition can be found through out the year. At glance, the antler's shapes of Bawean deer are closely symmetrical (Table 4) except if we look at the angle of the second tines. The change of body size on two young deer showed a quite rapid change at the age of six months old (Table 5), which was coincident with the pedicles growth. At roughly the same age the hair molting phase also occurred, starting from the neck area and followed to a lower abdomen, legs and body and took about 25- 40 days to complete. The molted hairs tend to be longer and smoother compared to the new ones. The color of the new hair at the body's backside is light brown for the hinds and rather dark brown for the stags with the hair length of 22.5 mm (SD = 0.79; n=85).

Although Bawean deer is considered as a small deer, but the initiation of pedicle growth in this species is not different from the bigger deer such as sambar deer (*Cervus unicolor*) or red deer (*Cervus elaphus*), i.e. at the age of 6 - 8 months (Semiadi *et al.*, 1994; Muir *et al.*, 1985). This clearly shows that the body size does not give significant difference

towards the secondary sexual appearance. The size of Bawean deer antler's is relatively small compared to other tropical deer. The main beam is about 49% shorter than that of sambar deer or 25% shorter from that of Javan deer (*Cervus timorensis*). Whilst the antler's diameter of Bawean deer was around 35% and 48% respectively, smaller compared to that of sambar or Javan deer (Semiadi 1997). Bubenik & Konig (1985) gave hypotheses that the lengths and angles of the various antler's tines are under the control of some kind of compensatory shaping mechanism. This is shown by the presence of symmetrical tendency figures at antler's morphometry, as also shown in Bawean deer. Bubenik (2001) stated that there is a tendency that antler's size is influenced by social status among their groups, as well as the level of male sexual hormone. A big size antler indicates that the male in the previous mating season was dominant. The presence of synchronization between the fall of testes into scrotum, the increase of body's growth and the hair molting process with the growth of pedicle, indicates that the physiologically drastic change in Bawean deer most likely occurs at around 6 - 7 months old.

Table 4. Morphometry (mm) of hard antlers in adult Bawean deer.

	Length of main beam		Length of first tine		Length of second tine	
	Right	Left	Right	Left	Right	Left
MZB1848	343	376	156	138	57	60
MZB12638	313	316	125	122	70	91
MZB3737	293	300	112	121	35	64
Wild	325	330	92	109	112	99
Mean	318.5	330.5	121.3	122.5	68.5	78.5
SD	21	32.72	6.85	11.9	32.4	19.4

Identity	Length of main beam tip		Antlers diameter		Antlers span	
	Right	Left	Right	Left	Main tip	Second tine
MZB1848	72	128	20.86	20.96	266	218
MZB12638	111	121	11.67	20.79	264	168
MZB3737	90	105	18.04	18.39	248	79
Wild	110	114	20.11	20.08	289	142
Mean	95.8	117	17.7	20.1	266.8	151.8
SD	18.55	9.83	4.17	1.17	16.88	57.85

Identity	Antlers span	Angle of first tine (^{0})		Angle of second tine(^{0})	
	First tine	Rightt	Left	Rightt	Left
MZB1848	237	62	55	75	79
MZB12638	188	60	65	81	59
MZB3737	23	60	62	73	65
Wild	172	60	62	70	84
Mean	155	60.5	61	74.8	71.8
SD	92.24	1	4.24	4.65	11.7

Table 5. Body size changes (mm) in young captive Bawean stags (n=1-2).

Age (month)	3	5	6	10
Shoulder height	430; 470	460; 485	485; 500	575
Body length	440; 500	475; 510	575	610
Body circumference	435; 480	450; 490	500; 530	560
Live weight (kg)	---	---	16.2	22.9

In comparison with the antler's growth of sambar deer, the Bawean deer had in hard antler's period and velvet growth approximately 19% (39 days) and 49% (67 days) respectively, shorter than in sambar deer (Semiadi *et al.*, 1994). Muir *et al.* (1985) reported that in red deer the duration of antler's growth from casting to hard antler's conditions was about 23 $\pm$ 0.5 weeks. They also stated that at the age of four weeks of antler's growth the length of antler's has reached 21% of its total length, and at the age of 16 weeks has reached up to 95% of its total length. Mas'um and Affandhy (1992) reported that in captivity, the dominant Bawean stag had in hard antler's condition for a record of 16 months. The condition of hard antler's reaching a year or more seems as a specific characteristic of tropical deer as found in sambar, chital (*Axis axis*) and Javan deer, though the intensity is low. The longest period being recorded for a stag in hard antler's in this research was at least eight months and went on till research ended. This stag also showed its dominant characteristic for its ownership on female harem.

One specific characteristic of Bawean deer is its front legs that are relatively shorter than its hind legs resulted in a sloping forward (Blouch and Atmosoedirdjo 1987). This is also seen in one wild Bawean deer caught during the research, though it is not quite obvious as in the captive ones. Wild Bawean deer tend to have relatively slimmer bodies with dark color of hair in comparison with captive deer. Considering all captive deer in Indonesia, and also in overseas, originally came from one gene pool, i.e. the Surabaya Zoo, it is therefore necessary to conduct a research on the possible genetic degradation. Blouch & Atmosoedirdjo (1978) indicated that the founders of Bawean deer in Surabaya Zoo were three hinds and two stags that were captured between 1969 and 1972.

From this study it can be concluded that the period of physiological change process in relation to antler's growth and some reproductive activities in Bawean deer begins from six months of age, which was not different compared to that of other tropical or temperate deer. Further research links to the understanding of reproductive physiology is urgently needed in preserving these deer especially in their natural habitat.

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