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SHORT NOTE

TOOTH WEAR PATTERN IN FORMOSAN REEVES' MUNTJAC (*MUNTIACUS REEVESI MICRURUS*)

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Kurtis C. J. Pei and Ying Wang (1991) Tooth wear pattern in formosan Reeves' muntjac (*Muntiacus reevesi micrurus*). *Bull. Inst. Zool., Academia Sinica* **30**(4): 341-344. The relationship between age and the mean crown height (MCH) of the first lower molars (FLM) for adult Formosan Reeves' muntjac (*Muntiacus reevesi micrurus*) was investigated. Two best fitted regressions, one linear and one curvilinear, were calculated and the theoretical life-span, derived from the regressions, were 9 and 11 years respectively. With a 50% confidence, the range of the MCH of the FLM for each age class up to 8 years old was prepared for field study.

Key words: Formosan Reeves' muntjac, Tooth wear pattern.

To gain insight into survivorship or reproduction, a number of attempts have been made to determine the age of adult muntjac. Van Bemmel (1952) adopted the aging system prepared for the roe deer (*Capreolus capreolus*) in his study of the Indian muntjac (*Muntiacus muntjak*), which has been shown to under estimate the age of muntjac (Chapman *et al.*, 1985). More recently, Sheng and Wang (1976) and Sheng and Lu (1981) counted the cementum layers in the root of the first upper molar to determine the age for the Reeves' muntjac (*M. reevesi reevesi*) and the black muntjac (*M. crinifrons*), respectively. Though cementum layers may prove to be reliable (H.L. Sheng, pers. comm.; Wang, 1989), an easily applied aging technique is still desirable for field study.

In this study we investigated the change of the crown height of the first lower molar (FLM) with age for the Formosan Reeves' muntjac (*M. reevesi micrurus*) using skulls collected from I-Lan, Taiwan. Hopefully, we could establish basic information for future study of muntjac aging in the field.

MATERIALS AND METHODS

Twenty-two skulls were collected for the study (Table 1). The ages of these skulls were determined by observing the

pattern of their dental eruption and counting the cementum layers in the root of the FLM (Wang, 1989). For each skull, heights of the anterior and posterior buccal cups of both the left and right FLM were measured, as described in Robinette *et al.* (1957), to the nearest 0.25 mm. To avoid the possible bias of uneven wear (Sinclair, 1977; Taylor, 1988), the average of these 4 measurements was used to estimate the mean crown height (MCH) of the FLM. Due to the small sample size and the lack of males older than 4 years, we pooled the data obtained from both sexes.

Because muntjac are born every month (Chapman *et al.* 1984), we assigned each animal an age which represented the mid-point of its year-class during the calculation. Animals between 1.5 and 2 years old (identified through tooth eruption) were all designated as 1.75 years old, animals between 2 and 3 years old (identified through the counting of cementum layers) were designated as 2.5 years old, and so forth.

The correlation between the MCH of the FLM and the age of the same tooth was determined by calculating the best fitted regression line. For the purposes of establishing an aging system to estimate the age of specimens examined in the field, we further calculated the confidence intervals of the MCH of the FLM for each age class by using the equation given by Zar (1984). The significant level that produced the least overlap between the ranges of confidence intervals of adjacent age classes was used.

Table 1
Muntjac skulls collected from I-Lan, Taiwan

Estimated Age (years)	Male	Female
1.5-2	6	3
2-3	2	3
3-4	2	1
4-5	0	3
5-6	0	0
6-7	0	1
7-8	0	1
Sum	10	12

RESULTS AND DISCUSSION

The age and the MCH of the FLM showed a significant negative correlation as indicated by the linear regression (Fig. 1): $Y=7.93-0.869X$, $r=0.93$; $p<0.001$, where Y=MCH (mm), and X=age. The

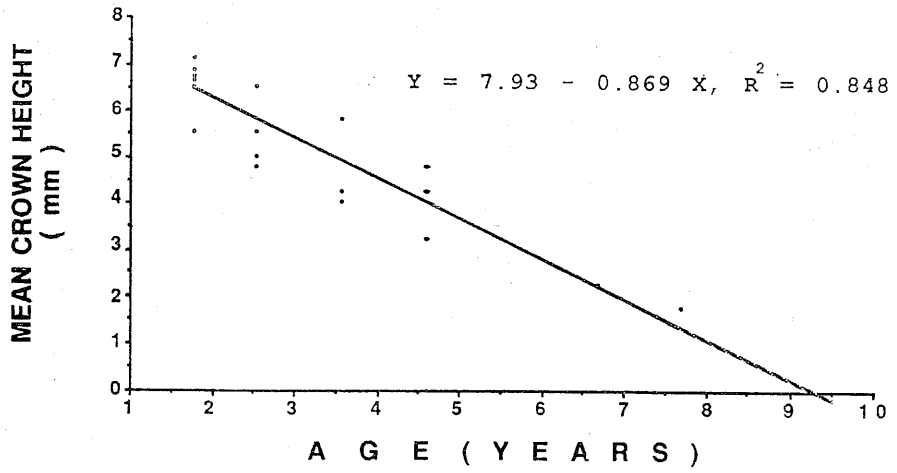

Fig. 1. Mean crown height of mandibular first molars plotted against ages. Ages were estimated according to the number of annuli in the tooth roots.

equation implies a theoretical life-span of about 9 years, when the cown of the FLM is worn to zero height, for the Formosan Reeves' muntjac.

Studies on African ungulates showed a concave, curvilinear relationship between the crown height of molars and age (Spinage, 1971, 1972, 1976; Taylor, 1988), and the following function predicted their correlation with high accuracy: $Y=Y_0[1-(X/N)^{1/2}]$, where Y=crown height at age X, Y_0=crown height in absence of wear, and N=life-span of the species. Using this curvilinear model, we obtained a model with slightly increased correlation coefficient: $Y=10.79\ [X/10.69)^{1/2}]$, $r=0.94$, $p<0.001$. The theoretical life-span predicted by this model is close to 11 years.

For convenience, the confidence intervals of MCH in each age class were calculated based on the linear equation (Table 2), since the linear and the curvilinear model showed no difference in their prediction of MCH values (t-test$=-0.335$, $df=5$, $p>0.5$). In practice, animals falling within the overlapped section of two adjacent age groups would be equally divided between the two age groups.

It should be noted that, in the present study, the MCHs were calculated against the mid-points of their age classes, which increased the variation within the corresponding age points. The true correlation should, therefore, be higher if MCHs are calculated against their actual ages (*i.e.* the 50% confidence level from the present calculation may be under-represented). The system should be refined in the future when more skulls of known age become available.

Table 2
The 50% confidence limits of the predicted MCH of the FLM for each age interval of the Formosan Reeves' muntjac in I-Lan, Taiwan

Estimated Age (years)	50% confidence intervals (mm)
<2	>6.0
2-3	5.3-6.2
3-4	4.4-5.3
4-5	3.6-4.5
5-6	2.7-3.6
6-7	1.8-2.8
7-8	0.9-1.9

Lastly, it is generally agreed that individuals who live in different areas might exhibit different tooth wear pattern due, presumably, to the fineness of local vegetations and soil types (Sinclair, 1977). However, because muntjacs are highly selective feeders that primarily feed on fine forage in their environments (Seidensticker and McNeely, 1975), the location-dependent variation in the tooth wear pattern should not be great for this species. Thus, we believe that our results, which were derived from one local population, could be applied to aging individuals from other areas in Taiwan

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REFERENCES

Chapman, D.I., N.G. Chapman and D.M. Colles (1985) Tooth eruption in Reeve's muntjac (*Muntiacus reevesi*) and its use as a method of age estimation. *J. Zool.* (*London*) **205**: 205-221.

Chapman, D.I., N.G. Chapman and O. Dansie (1984) The periods of conception and parturition in feral Reeves' muntjac (*Muntiacus reevesi*) in southern England, based upon age of juvenile animals. *J. Zool.* (*London*) **204**: 575-578.

Robinette, W.L., D.A. Jones, G. Rogers and J.S. Gashwiler (1957) Notes on tooth development and wear for Rocky Mountain mule deer. *J. Wildl. Manage.* **21**: 134-153.

Seidensticker, J. and J. McNeely (1975) Observations on the use of natural licks by ungulates in the Huay Kah Khaeng Wildlife Sanctury Thailand. *Nat. Hist. Bull. Siam Soc.* **26**: 24-33.

Sheng, H. L. and H. J. Lu (1981) Reproduction of the Chinese black muntjac (*Muntiacus crinifrons* Sclater). *Acta Theriol. Sinica* **1**(1): 14-18.

Sheng, H. L. and P. C. Wang (1976) The ecology and utilization of Reeves' muntjac. *Chinese J. Zool.* **1**: 39-40.

Sinclair, A. R. E. (1977) *The African buffalo—A study of resource limitation of population.* The Univ. Chicago Press, Chicago, Ill. 355 pp.

Spinage, C. A. (1971) Geratodontology and horn growth of the impala *Aepyceros melampus. J. Zool.* (*London*) **164**: 209-225.

Spinage, C. A. (1972) Age estimation of zebra. *E. Afr. Wildl. J.* **10**: 273-277.

Spinage, C. A. (1976) Incremental cementum lines in the teeth of tropical African mammals. *J. Zool.* (*London*) **178**: 117-131.

Taylor, R. D. (1988) Age determination of the African buffalo, *Syncerus caffer* (Sparrman) in Zimbabwe. *Afr. J. Ecol.* **26**: 207-220.

Van Bemmel, A. C. V. (1952) Contribution to the knowledge of the genera *Muntiacus* and *Arctogalidia* in the Indo-Australian Archipelago (Mammalia, Cervidae & Viverridae). *Beaufortia* **16**: 1-50.

Wang, M. N. (1989) The biological study on Formosan muntjac (*Muntiacus reevesi micrurus*)—Distribution, sexual dimorphism and age determination. M. S. Thesis. Natl. Taiwan Normal Univ., Taipei, Taiwan, R. O. C. 76 pp.

Zar, J. H. (1984) *Biostatistical analysis* (2nd ed.). Prentice-Hall, Inc., Englewood Cliffs, N. J. 718 pp.

臺灣山羌牙齒磨損與年齡之關係

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本研究在探討臺灣山羌 (*Muntiacus reevesi micrurus*) 成體的下顎第一臼齒的平均齒冠高與其年齡之間的關係。以直線和曲線迴歸計算所得之相關係數值，沒有顯著差異。由兩個迴歸方程式所顯示的此種動物之理論壽命，分別爲 9 和 11 歲。根據上述齒冠的磨損與年齡關係，所估算之各年齡齒冠高的 50%可信範圍，將可應用於野生個體年齡之判斷。