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Drozdz, A.; Goreck, A. (1967): Oxygen consumption and heat production in Chinchillas. Acta Theriol. Bialow. **12**, 81—86.
Ginglinger, A.; Kayser, Ch. (1929): Etablissement de la thermorégulation chez les homéothermes au cours du développement. Ann. Physiol. physicochim. biol. **5**, 710—758.
Hafez, E. S. E. (1964): Behavioral thermoregulation in mammals and birds. Int. J. Biometeor. **7**, 231—240.
Hensel, H. (1955): In Precht, H.; Christophersen, J.; Hensel, H.: Temperatur und Leben. Berlin, Göttingen, Heidelberg: Springer.
Hissa, R. (1968): Postnatal development of thermoregulation in the norwegian lemming and the golden hamster. Ann. Zool. Fenn. **5**, 345—383.
Kulzer, E. (1963): Temperaturregulation bei Flughunden der Gattung *Rousettus* Gray. Z. vergl. Physiol. **46**, 595—618.
McManus, J. J. (1972): Water relations of the Chinchilla; *Chinchilla laniger*. Comp. Biochem. Physiol. **41** A, 445—450.
McIntyre, D. G.; Ederstrum, H. E. (1958): Metabolic factors in the development of homeothermy in dogs. Amer. J. Physiol. **194**, 293—296.
Naaktgeboren, C.; Slijper, E. J. (1970): Biologie der Geburt. Hamburg u. Berlin: Paul Parey.
Östbye, E. (1965): Development of thermoregulation to age and growth in the norwegian lemming *(Lemmus lemmus* L.). Nytt. Mag. Zool. **12**, 65—75.
Seele, E. (1968): Haut und Haar der Chinchillidae. Zool. Anz. **181**, 60—75.
Walker, E. P. (1964): Mammals of the world. Baltimore: The Johns Hopkins Press.
Weigold, H. (1973): Jugendentwicklung der Temperaturregulation bei der Mausohrfledermaus, *Myotis myotis* (Borkhausen, 1797). J. comp. Physiol. **85**, 169—212.
Weisser, F.; Lacy, F. B.; Weber, H.; Jamison, R. L. (1970): Renal function in the Chinchilla. Amer. J. Physiol. **219**, 1706—1713.
Wilcox, H. H. (1950): Histology of the skin and hair of the adult Chinchilla. Anat. Rec. Phil. **108**, 385—397.

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Tooth wear as an indication of age in Badgers *(Meles meles* L.) and Red Foxes *(Vulpes vulpes* L.)

By P. J. H. van Bree, R. W. M. van Soest and L. Stroman

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Introduction

The examination of tooth wear has been an established method of age estimation of wild mammals for quite a long time. Particularly in wildlife management circles elaborate schemes of successive wear stages of the lower molars are used to determine the age of several species of deer in order to get some idea of the population structure. Similar but less elaborate age-wear schemes have been used in estimating age in various other mammals, such as Stoats, *Mustela erminea* L. Stroganow 1937), Gray Foxes *Urocyon cineroargenteus* (Schreber) (Wood 1958), Red Foxes, *Vulpes vulpes* L.

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(Stubbe 1965), Badgers, *Meles meles* L. (Stubbe 1965) and Pronghorns, *Antilocapra americana* (Ord) (Dow and Wright 1962). All authors concerned base their method of age determination on the assumption, that during life the teeth are gradually abraded by constant use, which in it self seems a sound assumption. However, to be of use as a reliable age indicator the wear of the teeth should be more or less similar and synchronic in all individuals of a population. This vital condition has not been taken into account in the past because most authors did not have any information on the relation between real age and estimated age, as they lacked a sufficient number of known age animals.

Recently, however, Rieck (1970) compared the wear of the molars of marked (and consequently known age) Roe Deer (*Capreolus capreolus* L.) with the schemes constructed by his fellow countrymen Nehring (1903, after Rieck 1970) and Brandt (1907, after Rieck 1970). He found that 80 % of the animals was aged accurately with the tooth wear schemes. The same was done by Keiss (1969) with Elk (*Cervus canadensis* Erxleben), but his percentage aged accurately appeared to be only 50 %. Grau et al. (1970) acquired an accuracy of 83 % with the tooth wear method applied in known age Raccoons (*Procyon lotor* L.), which were raised on a farm.

Kerwin and Mitchell (1971) studied the toothwear of Pronghorns, *Antilocapra americana* (Ord), which had been objectively aged by analysis of the growth layers in the cementum of their teeth. (A complete survey of this method and its reliability is given by Klevezal and Kleinenberg, 1969). Kerwin and Mitchell (l. c.) found a 61 % accordance. The same was done by Erickson et al. (1970) with Mule Deer,

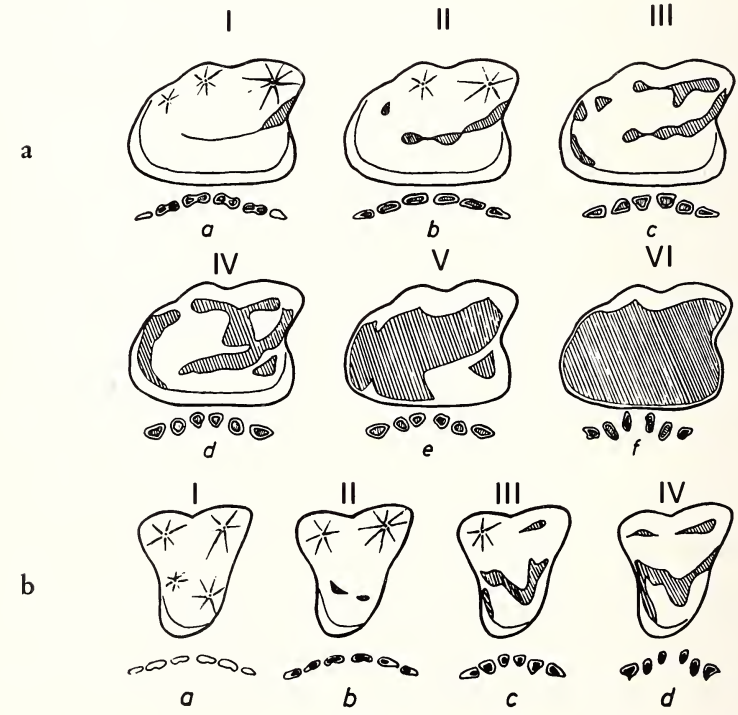

Fig. 1a. Tooth wear age stages of Badgers, *Meles meles* L., designed by Stubbe (1965). — *Fig. 1b.* Tooth wear age stages of Red Foxes, *Vulpes vulpes* L., designed by Stubbe (1965)

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Odocoileus hemionus (Rafinesque) and by GILBERT and STOLT (1970) with Maine White-tailed Deer, *Odocoileus virginianus* (Zimmermann). These authors found 38 to 63 %, viz. 60 % accordance between cemental growth layers and tooth wear.

The present paper deals with the reliability of the age determination by studying the tooth wear in Badgers (*Meles meles* L.) and Red Foxes (*Vulpes vulpes* L.). The material used for this study consisted of 70 skulls of Badgers, 41 of which were from the eastern and southern parts of the Netherlands, the remainder being from the west of France, and of 176 skulls of Red Foxes, 79 of which were from the Netherlands (mostly from the Veluwe area) and 97 from the western and southern parts of France. All material is deposited in the Zoological Museum of Amsterdam (ZMA). The objective age of all specimens was assessed by using the variant of the dentin layer method designed by STIRLING (1969), which consists of cutting the (canine) teeth in half, polishing and etching the cut surface and staining it with toluidin blue. The results of the analysis of the dentin growth layers are compared with the tooth wear schemes designed by WOOD (1958) and STUBBE (1965).

Thanks are due to Dr. J. L. VAN HAAFTEN and Drs. D. KRUIZINGA of the Netherlands' Research Institute for Nature Management for supplying the material from the Netherlands, and to Prof. Dr. J. A. RIOUX of the University of Montpellier and Mr. F. CHANUDET of the Muséum d'Histoire Naturelle at La Rochelle for collecting and donating the French material. Mr. L. A. VAN DER LAAN took care of the photographic reproduction.

Objective age and tooth wear in Badgers

As the available Badger material was rather limited the skulls from France and from the Netherlands were considered together. Figure 1a, which has been copied from STUBBE (1965) represents the scheme for the wear of the first molar (M^1) and the lower incisors. STUBBE (1965) estimated Badgers with wear stage I to be 7—9 months old; stage II is supposed to occur in animals 19—21 months old; stage III 31—33 months old; stage IV—VI over 33 months old. The narrow range of the different stages is caused by the fact that STUBBE's animals were all captured in the fall.

The present material is from all months of the year, so the scheme of STUBBE (l. c.) had to be modified. Stage I is considered to represent animals of 0—12 months old, stage II 12—24 months old, stage III 24—36 months and stage IV—VI over 36 months old. The tooth wear age estimated in this way is compared with the objective age as it was established by way of the dentin layer method. From fig. 2, which represents this comparison, it is clear that, although a general correlation between tooth wear age and objective age is not to be denied, a large part of the material was aged wrongly with the tooth wear method. Compared in detail

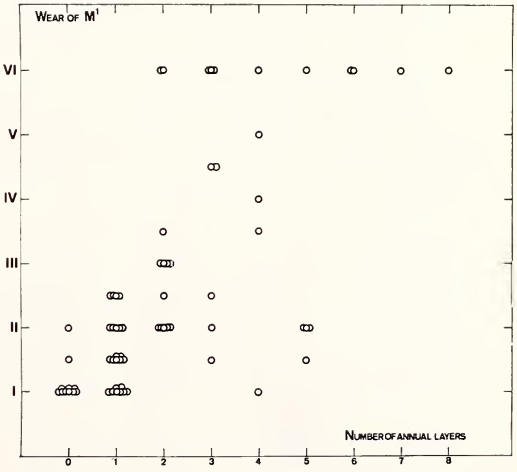

Fig. 2. Comparison of tooth wear age (vertical axis) and number of dentinal annuli (horizontal axis) in Badgers, *Meles meles* L. from the Netherlands and France

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59 % was aged correctly, allowing for the fact that Stubbe (l. c.) did not specify age groups over 36 months old, although his stages V and VI suggest a further wear-age relation.

Extreme disagreement has been found in ZMA reg. no. 4062, 8705 and 10985, which were classed in wear stage II, although their objective age appeared to be 60—67 months. A point of interest is the phenomenon of unequal wear of the molars in both halves. In a number of cases the wear stage of a specimen had to be averaged as left and right molars did not concur.

Objective age and tooth wear in Red Foxes

Fairly ample material from both the Netherlands and France was available, so the two collections were considered separately. Figure 3, which was copied from Wood (1958), represents the wear scheme for Gray Fox first upper molars. Five age groups are distinguished: 0 (0—12 months old), I (12—24 months), II (24—36 months), III (36—48 months) and IV (over 48 months). Stubbe (1965) adapted this scheme to his material of Red Foxes, limiting the number of age groups to four (fig. 1b): I (8—10 months old), II (20—22 months), III (32—34 months) and IV (over 36 months). As the material upon which the present study is based, was captured in all months of the year, and not as Stubbe's material only from the fall, Wood's scheme (1958) was chosen to be compared with the objective age as it appeared from the dentin layers. From figure 4, which represents the comparison between tooth wear and objective age in Red Foxes from the Netherlands, and figure 5, which represents the same in Red Foxes from France, similar conclusions can be drawn as with the Badgers: a general correlation is apparent, but many specimens have been aged wrongly with the tooth wear method. Only 35 % of the Red Foxes from the Netherlands and 47 % of the french were aged in accordance with their objective age.

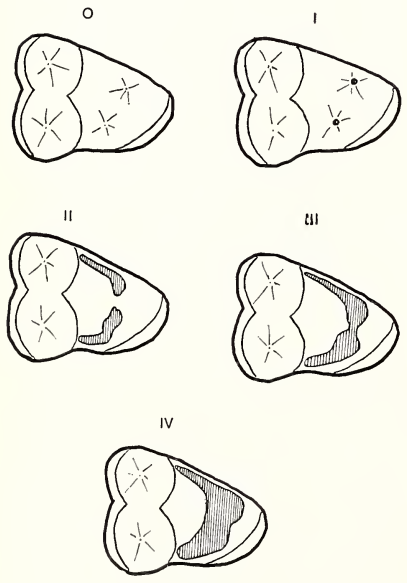

Fig. 3. Tooth wear stages of age Gray Foxes, Urocyon cineroargenteus (Schreber), designed bei Wood (1958)

Noteworthy disagreements between tooth wear age and real age have been observed in ZMA reg. no. 8710 (8 months old and tooth wear stage II), no. 8763 (12 months old and tooth wear stage III) and no. 15414 (24 months old and tooth wear stage IV). Most disagreements, however, did not exceed the period of one year.

Discussion

From the results presented in this study and those of Kerwin and Mitchell (1969), Keiss (1971), a. o., it must be concluded that the tooth wear method in general is an unreliable method to asses the age structure of a population sample. The great variability in the wearing process is probably due to such factors as the genetic background of the individuals, the size of the litter they originated from, the structure and the calcium content of the food taken

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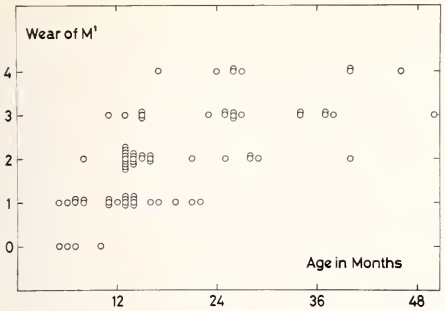

Fig. 4. Comparison of tooth wear age (vertical axis) and objective age, calculated from dentinal growth layers (horizontal axis), in Red Foxes, *Vulpes vulpes* L., from the Netherlands

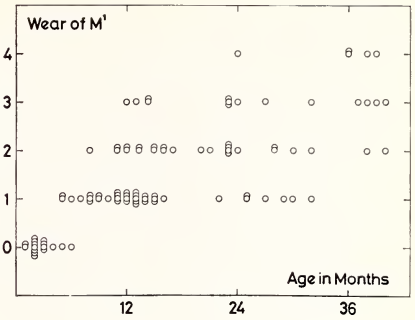

Fig. 5. Comparison of tooth wear age (vertical axis) and objective age, calculated from dentinal growth layers (horizontal axis), in Red Foxes, *Vulpes vulpes* L., from France

regularly and the individual variation in calcium metabolism. Concerning the food taken regularly, it was found by Andersen (1955, after Skoog 1970) and Skoog (1970) that the diet of Badgers from Denmark and Sweden depends largely on the availability of the particular kinds of food.

It is possible that the tooth wear method has a greater reliability, when the sampled population lives in an enclosed uniform area, in which factors as food and available calcium are the same for all members of the population. Grau et al. (1970) proved with captive known age Raccoons that aging by tooth wear of animals which have lived under similar optimal conditions might be nearly as accurate as that by counting annual deposits in the teeth. In most other instances, however, allowance should be made for about 40—60 % incorrect aging when studying large samples, and probably still more with small samples.

Zusammenfassung

Zahnabnutzung zur Bestimmung des Alters bei Dachsen (Meles meles L.) und Rotfüchsen (Vulpes vulpes L.)

Die Altersbestimmung von Dachsen (*Meles meles* L.) und Rotfüchsen (*Vulpes vulpes* L.) durch Zahnabnutzungsmerkmale wurde verglichen mit der objektiven Altersbestimmung durch das Zählen jährlicher Wachstumsschichten im Dentin der Zähne. Nur bei 35—60 % der untersuchten Exemplare stimmten die beiden Methoden überein. Die Altersbestimmung durch Zahnabnutzungsmerkmale wird als eine unzuverlässige Methode zur Untersuchung der Altersstruktur einer Raubtierpopulation betrachtet.

Summary

Age determination of Badgers (*Meles meles* L.) and Red Foxes (*Vulpes vulpes* L.) by tooth wear characteristics has been compared with the objective age determination by counting the annual growth layers in the dentin of teeth. In 35—60 % of the studied specimens tooth wear age and objective aged corresponded. Age determination by tooth wear characteristics is considered an unreliable method to study the age structure of a carnivore population.

References

Dow, S. A.; Wright, P. L. (1962): Changes in mandibular dentition associated with age in Pronghorn antilope. J. Wildl. Managem. **26**, 1—18.

Erickson, J. A.; Anderson, A. E.; Medin, D. E.; Bowden, D. C. (1970): Estimating ages of mule deer — an evaluation of technique accuracy. J. Wildl. Managem. **34**, 523—531.

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Gilbert, F. F.; Stolt, S. L. (1970): Variability in aging Maine white-tailed deer by tooth wear characteristics. J. Wildl. Managem. **34**, 532—535.
Grau, G. A.; Sanderson, G. C.; Rogers, J. P. (1970): Age determination of Raccoons. J. Wildl. Managem. **34**, 364—372.
Keiss, R. E. (1969): Comparison of eruption-wear patterns and cementum annuli as age criteria in elk. J. Wildl. Managem. **33**, 175—180.
Kerwin, M. L.; Mitchell, G. J. (1971): The validity of the wear-age technique for Alberta pronghorns. J. Wildl. Managem. **35**, 743—747.
Klevezal, G. A.; Kleinenberg, S. E. (1969): Age determination of mammals by layered structure in teeth and bone. (Akad. Nauk S. S. S. R., Inst. Morf. Zhiv., Izdatelstvo Nauka, Moscow, 1—144.) Fish. Res. Board Canada, Transl. Ser. 1024, 1—142.
Rieck, W. (1970): Alter und Gebißabnutzung beim Rehwild. Z. Jagdw. **16**, 1—7.
Skoog, P. (1970): The food of the Swedish Badger, *Meles meles* L. Viltrevy **7**, 1—120.
Stirling, I. (1969): Tooth wear as a mortality factor in the Weddell Seal, *Leptonychotes weddelli*. J. Mammal. **50**, 559—565.
Stroganov, S. U. (1937): A method of age determination and an analysis of the age composition of ermine populations (*Mustela erminea* L.). Zool. Zhurn. **16**, 113—129.
Stubbe, M. (1965): Zur Biologie der Raubtiere eines abgeschlossenen Waldgebietes. Z. Jagdw. 11, 73—102.
Wood, J. (1958): Age structure and productivity of a gray fox population. J. Mammal. **39**, 74—86.

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Wurfzahl und Wurffolge beim nordischen Wiesel (*Mustela nivalis rixosa* Bangs, 1896)

Von F. Frank

Biologische Bundesanstalt für Land- und Forstwirtschaft, Braunschweig

Eingang des Ms. 12. 5. 1973

Bei ausreichendem Beutetierbestand sind beim mitteleuropäischen Mauswiesel (*Mustela nivalis vulgaris* Erxleben, 1777) zwei Jahreswürfe die Regel. Den Wieseln nördlicher Breiten steht infolge des erheblich kürzeren Sommers keine gleichlange Fortpflanzungszeit zur Verfügung. Dennoch ist ihre Vermehrungsfrequenz offensichtlich nicht geringer und nur erklärbar, wenn gleichfalls zwei Jahreswürfe angenommen werden (O. Kalela 1960 in mündl. Diskussion).

1964 konnte ich ein schwedisches Wiesel-Weibchen in Zucht nehmen, das nach Größe, Gewicht und Färbung der zirkumpolaren Unterart *rixosa* angehörte (genaue Daten in einer weiteren Veröffentlichung). Dieses brachte 1965, 1966 und 1967 je drei Würfe und bewies damit, daß auch das nordische Wiesel physiologisch auf mehr als einen Jahreswurf eingestellt ist. Daß es im natürlichen Verbreitungsgebiet mehr als zwei sein könnten, ist allerdings unwahrscheinlich. Der in Gefangenschaft produzierte dritte Wurf dürfte als Reaktion auf den längeren mitteleuropäischen Sommer

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