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AGE DETERMINATION IN CAPE MOUNTAIN ZEBRAS *EQUUS ZEBRA ZEBRA* IN THE MOUNTAIN ZEBRA NATIONAL PARK

B. L. PENZHORN

Department of Genesiology
Faculty of Veterinary Science
University of Pretoria
P.O. Box 12580
Onderstepoort
0110

Abstract — The sizes of foals up to two years old can be used for age estimation in the field. Tooth eruption and replacement, which is similar to Hartmann and plains zebras, can be used for age estimation up to four years. No age classes based on tooth wear could be defined, due to the paucity of material. Infundibula in the incisors are retained to a greater age than in Hartmann or plains zebras. Cementum layer counts offer a reliable age determination method, at least up to 15 years.

Introduction

The ability to determine the age of an individual has become a necessity in modern wildlife management. This knowledge is necessary for studies of growth rate, determination of age at puberty, reproductive lifespan, longevity and even social behaviour. Extreme precision in age determination is often more of academic than of practical interest and relatively crude methods, empirically speaking, are often sufficient (Spinage 1973). The age of a juvenile animal can be estimated by comparing its size to that of its mother. Age estimation by means of the teeth is a common procedure in adult animals, where both tooth wear and counts of cementum annulations are used as age class criteria. In the domestic horse *Equus caballus*, tooth replacement and wear are used to estimate the ages of individuals with a high degree of reliability (Ensminger 1969; Miller & Robertson 1959; Wade 1982). The same attributes have been used for age determination in plains zebras *E. burchelli* (Erz 1964; Klingel & Klingel 1966; Spinage 1972; Smuts 1974) and Hartmann zebras *E. zebra hartmannae* (Joubert 1972).

Definition of age class criteria for the Cape mountain zebra *E. z. zebra* population in the Mountain Zebra National Park, Republic of South Africa, was attempted during a general ecological study of the population. A number of known-age foals died during the present study, as well as a mare known to be six years old, a nine-year-old stallion and three animals known to be at least 15 years old. Several other skulls were available for study. Tooth eruption and replacement are described, but

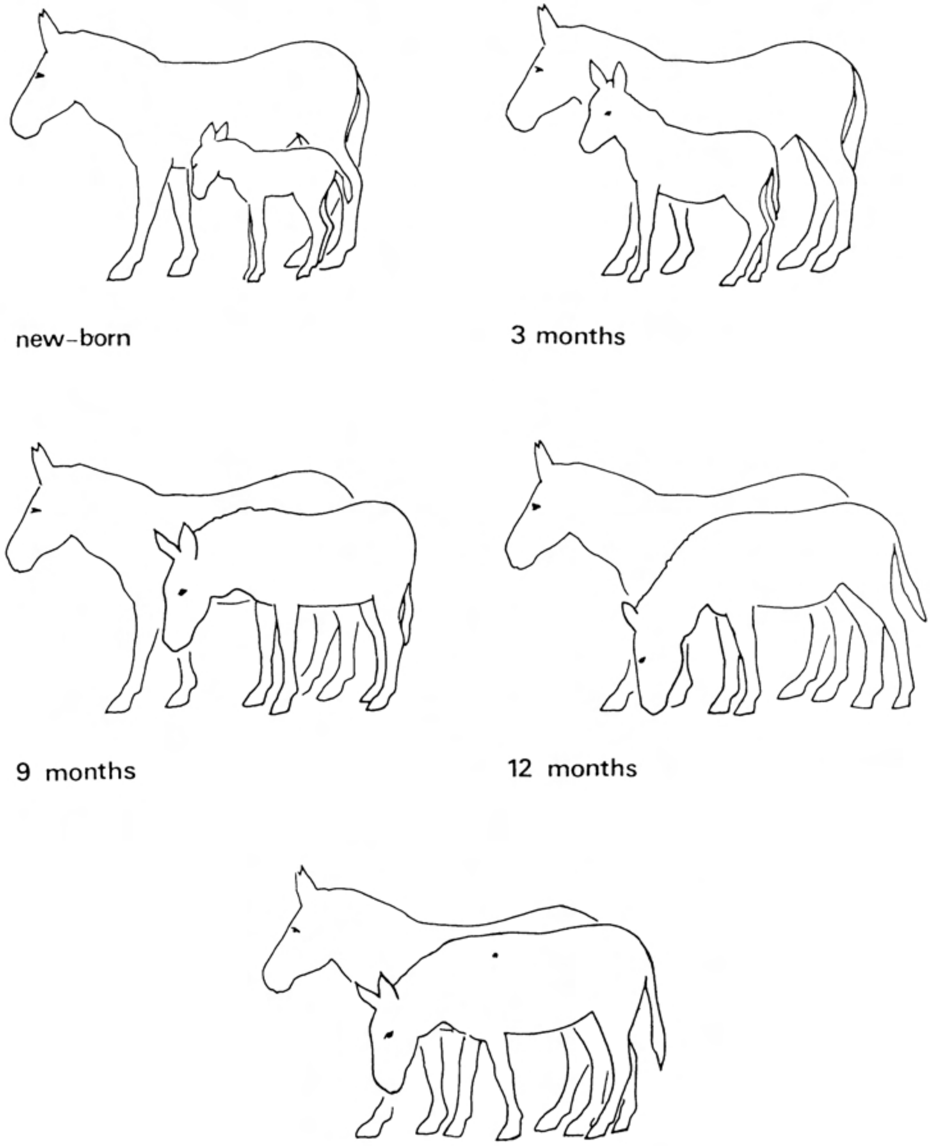


Fig. 1. Drawings of Cape mountain zebra foals at various ages compared with the size of the dam. Taken from photographs of known-age individuals.

due to the paucity of material, age classes based on tooth wear could not be defined. The dentition of the skulls of known-age individuals is described for comparison with other equid populations.

Methods

1. Known-age foals were photographed next to their dams. The images of all mares were enlarged to the same size and the outlines of their foals were traced on transparent paper. The tracings of the foals were then superimposed onto the outline of a standard-sized mare.
2. All the available skulls were photographed and arranged in a series of presumed increasing ages on the basis of tooth eruption and replacement and the changes in the shape of the infundibulum.
3. Cementum layer counts were done on permanent upper first incisors only. The crown of the tooth was removed and the root was decalcified in a 5% solution of trichloro acetic acid. The acid was changed regularly, at least every other day. Decalcification was complete in four to five weeks. The decalcified teeth were imbedded in wax and 5 μ longitudinal sections were made. The sections were fixed to a slide with Haupt's solution, stained for 15 minutes in Delafield's haematoxylin, blued in running water and counterstained in aqueous eosin. Finally, the sections were mounted in Canada Balsam under a cover slip. A projection microscope was used to count the cementum layers. Although decalcification of the entire tooth is a time consuming process, its advantages over the section-and-grind technique are that nothing of the material is lost in preparation of the slides, that many sections can be made of the same tooth and that the sections can be made much thinner.

Results and Discussion

Growth

The size of a Cape mountain zebra foal can be used for age estimation in the field. Until the foal is two years old, its age can be estimated reasonably accurately by comparing its size to that of its mother (Fig. 1).

Tooth replacement and eruption

The dental formula of Cape mountain zebras is identical to that of the other recent equids:

deciduous dentition $\frac{\text{Id3 Cd1 Pd4}}{\text{Id3 Cd1 Pd4}}$

permanent dentition $\frac{\text{I3 C1 P3 M3}}{\text{I3 C1 P3 M3}}$

(I=incisor, C=canine, P=premolar, M=molar, d=deciduous)

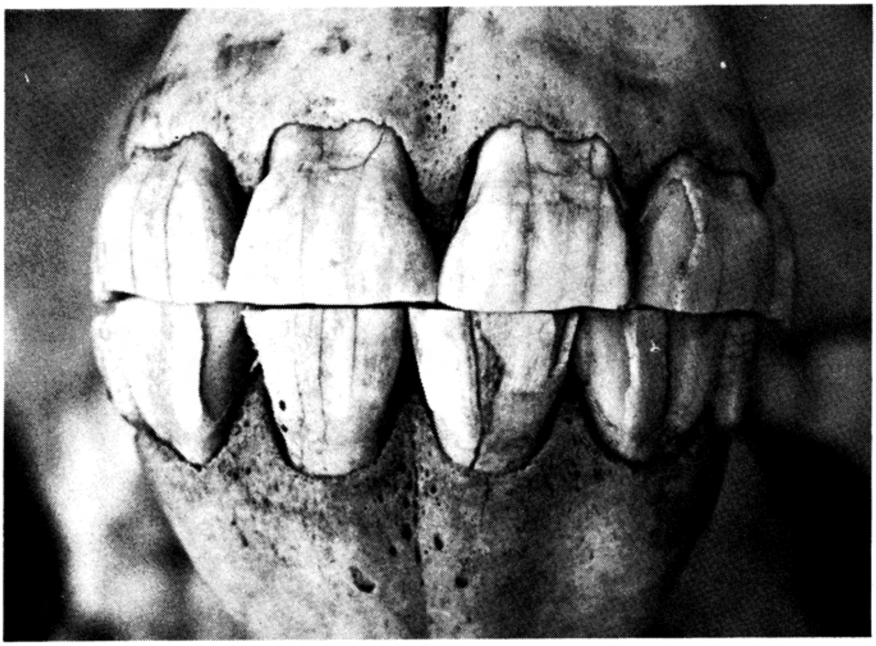


Fig. 2. Deciduous incisors of a Cape mountain zebra — note the definite neck.

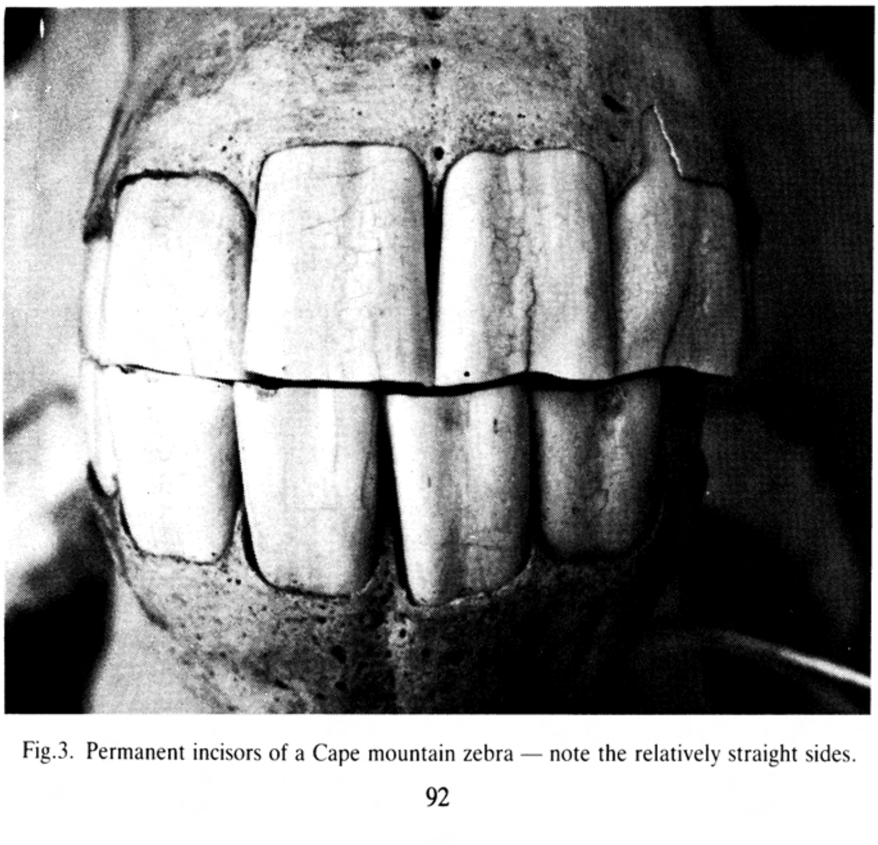
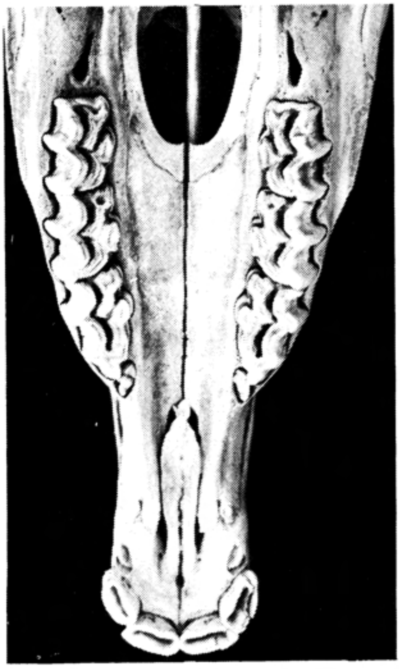


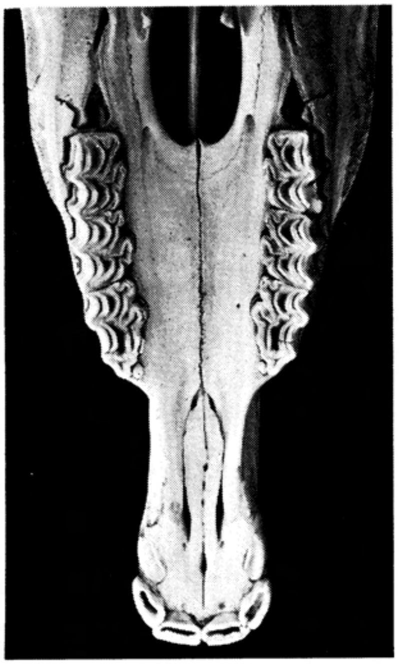
Fig.3. Permanent incisors of a Cape mountain zebra — note the relatively straight sides.

Well-developed permanent canines are present in stallions only and can be used to sex skulls. Canines in mares are rudimentary or absent. Deciduous canines are present in both colts and fillies, but never pierce the gum. The deciduous incisors have a definite neck (Fig. 2) and can readily be distinquished from the permanent incisors, which have straight sides (Fig. 3). The deciduous first premolars or "wolf teeth" are rudimetary and are soon lost. They are not replaced.

Fig. 4. Dentition of Cape mountain zebras of various ages from the Mountain Zebra National Park.



(a) three months

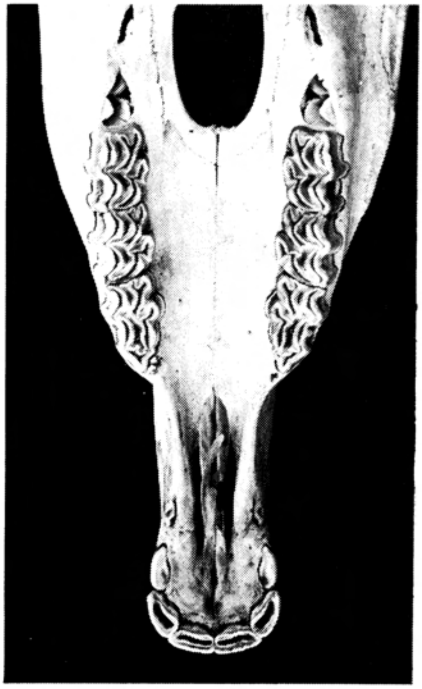


(b) six months

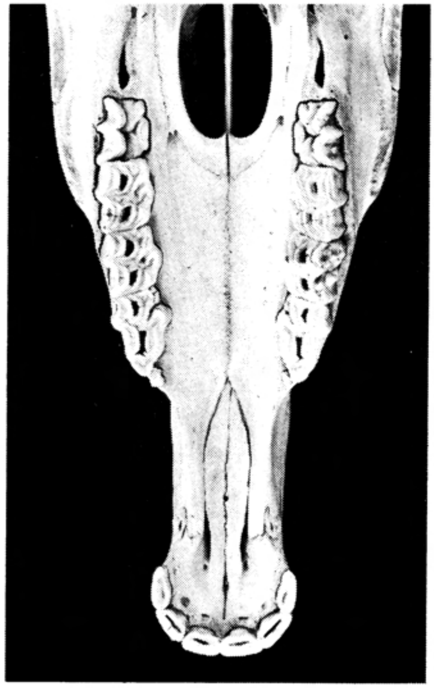
The chronology of tooth eruption and replacement seem to correspond fairly well with that described for Hartmann and plains zebras. The dentition of a Cape mountain zebra foal known to be three months old corresponded closely with Hartmann and plains zebra foals of similar age: Id1, Id2 and Pd2-4 are in wear, but M1 is not yet visible in its alveolus (Fig. 4a).

In a Cape mountain zebra foal known to be six months old, Id3 has erupted, M1 is approaching the level of the maxilla but does not yet project beyond it and M2 is visible in its alveolus (Fig. 4b). This agrees closely with Hartmann and plains zebras.

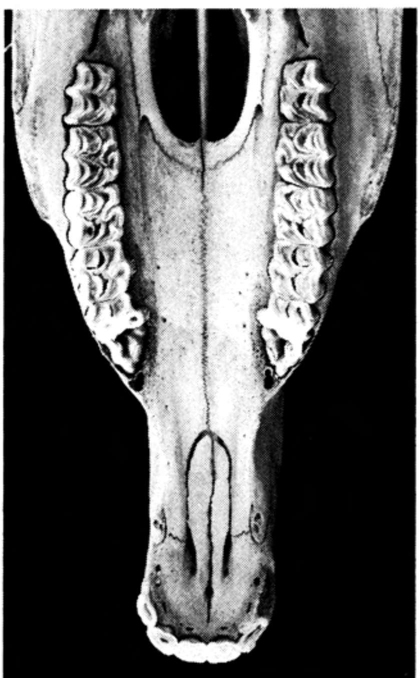
In a *ca* one-year-old Cape mountain zebra foal, Id3 is in wear and M1 had erupted but is not yet in wear (Fig. 4d). Once again, this correlates well with Hartmann and plains zebras.



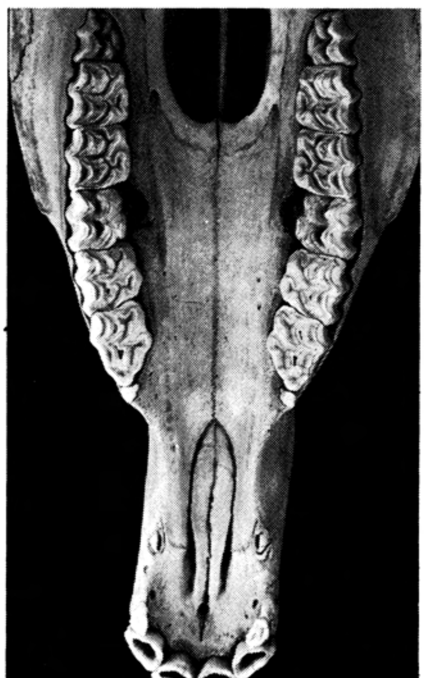
(c) seven months



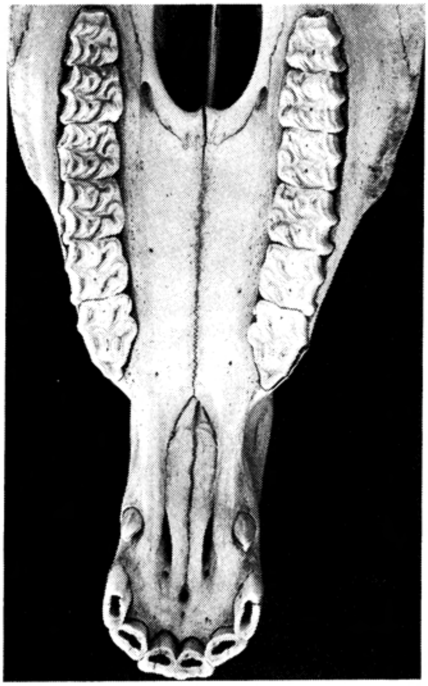
(d) one year



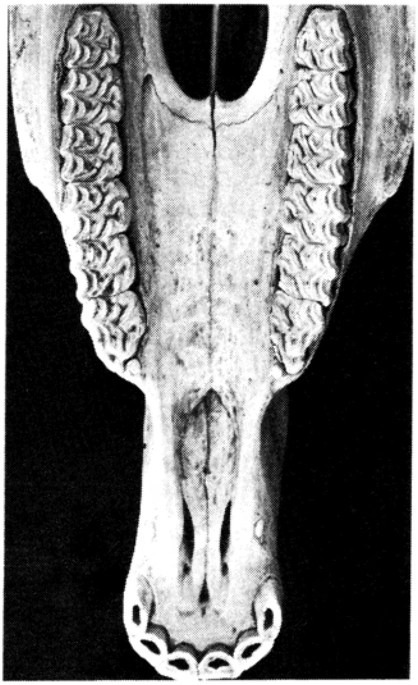
(e) *ca* two years



(f) *ca* three years



(g) *ca* five years



(h) six years

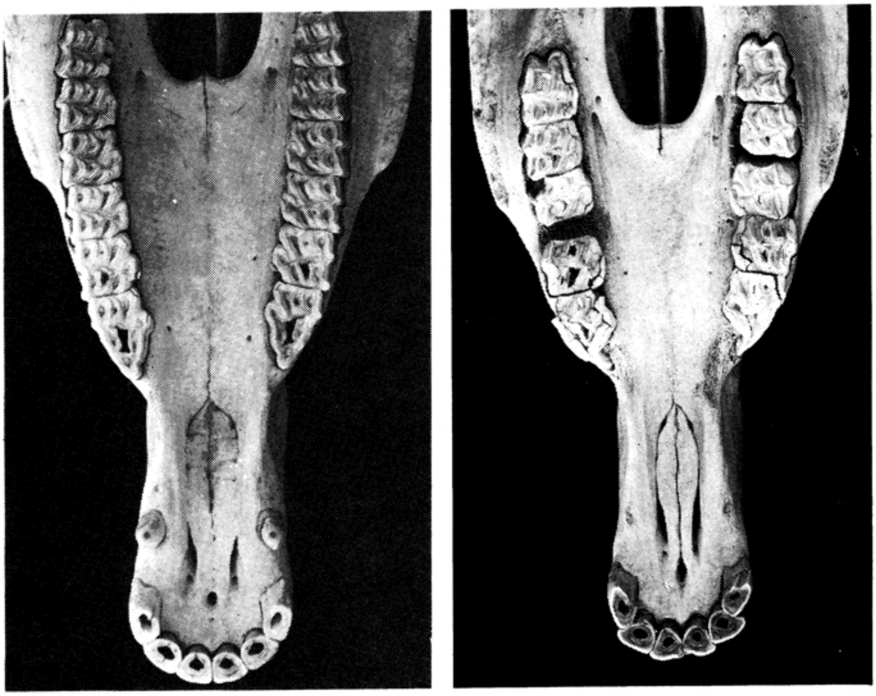
In a *ca* two-year-old Cape mountain zebra, M2 is erupting and P2 is replacing Pd2, while Id1 is still present (Fig. 4e). This differs from the general pattern in Hartmann and plains zebras where P2 replaces Pd2 only after I1 has replaced id1.

In a *ca* three-year-old Cape mountain zebra, I1 and I2 have replaced Id1 and Id2 respectively, P4 had replaced Pd4 and M3 and C are erupting (Fig. 4f). In both Hartmann and plains zebras M3 is generally in wear by the time P4 replaces Pd4.

Tooth eruption is not a constant reaction to a precise stage of development and cannot be regarded as a reliable measure of age by itself, but is acceptable as a crude measure of age (Steenkamp 1975). Individual differences in eruption chronology are unlikely to be significant (Spinage 1973). The differences described between Cape mountain zebras, Hartmann and plains zebras are slight and probably do not exceed intraspecific differences in the latter two. The chronology of tooth eruption and replacement in Cape mountain zebras is therefore essentially similar to that in the two African equids where it has been described and one may assume that the full complement of permanent teeth has erupted by age four years.

Tooth wear

An infundibulum occurs in the incisors of all recent equids, consisting of a depression or hollow running down the centre of the incisor for a variable length. The infundibulum is lined with enamel. The shape of the infundibulum changes as the incisors wear down. Klingel & Klingel (1966) stated that *ca* 4 mm of a plains zebra incisor is worn away per annum, but Smuts (1974) found the rate to vary with age in



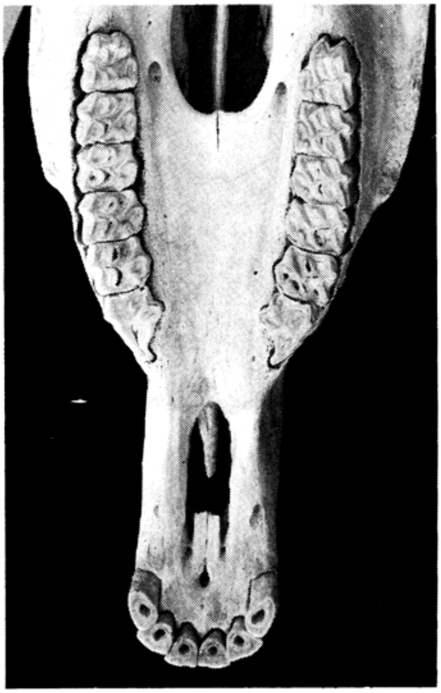
(i) nine years (j) *ca* 10 years

plains zebras in the Kruger National Park.

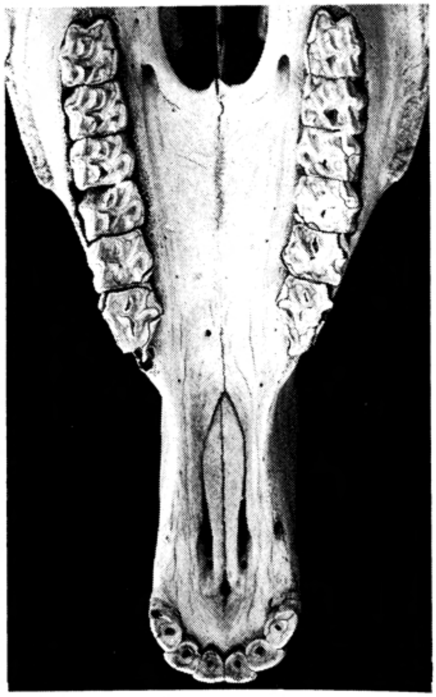
The shapes of the infundibula in the incisors of the known-age six-year-old Cape mountain zebra mare (Fig. 4h) agree closely with those described for Hartmann and plains zebras. A known-age nine-year-old Cape mountain zebra stallion similarly falls well within the criteria defined for Hartmann and plains zebras of similar age (Fig. 4i).

In three Cape mountain zebras known to be at least 15 years old, infundibula are still present in all the incisors (Figs. 4k, 4l and 4o). In Hartmann zebras, the infundibulum in I1 is completely worn away by 11-13 years, and the infundibula are absent in the incisors of animals older than 15 years. The infundibulum of I1 of plains zebras in East Africa is worn away at 11-13 years, but in the Kruger National Park population this only occurs at 15 years. The infundibula of one of these 15-year-old Cape mountain zebra mares (Fig. 4l) resemble those of a 12-year-old plains zebra (Smuts 1974). Even in the oldest Cape mountain zebra depicted (Fig 4p), with P2 nearly worn away, faint traces of the infundibula are still visible in the incisors.

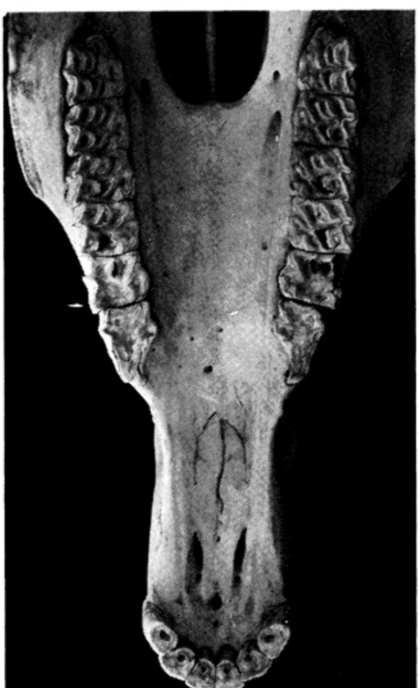
No definition of age classes according to wear is attempted on the basis of the short series of skulls. Spinage (1973) pointed out that the wear of the teeth, like any other biological character, is likely to follow a normal curve of distribution in relation to a specific age and that it is unrealistic to expect agreement. The mean should rather be used and this implies adequate sampling of a large population. The paucity of material available during the present study precludes any definite conclusions.



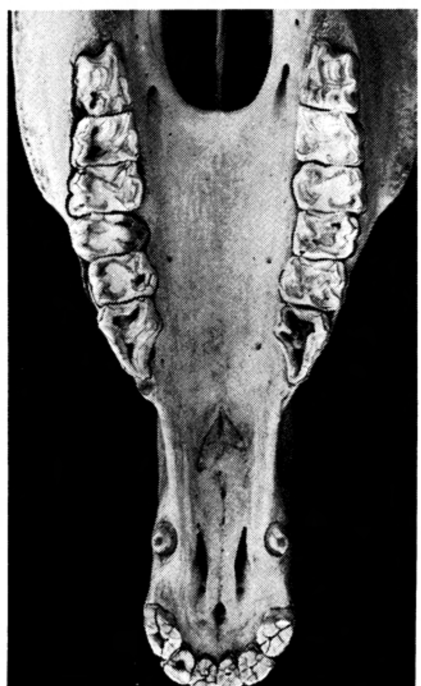
(k) >15 years



(l) >15 years



(m) *ca* 18 years (?)



(n) *ca* 18 years (?)

(o) >15 years (possibly 20 years?) (p) very old (20+ years ?)

However, it would appear that infundibula in the incisors of Cape mountain zebras in the Mountain Zebra National Park population are present to a greater age than in Hartmann zebras in SWA/Namibia and in plains zebras. This may be due to either a slower rate of wear or longer infundibula. It was impossible to measure the length of the infundibulum in newly-erupted Cape mountain zebra incisors for comparison with plains zebras (Klingel & Klingel 1966; Smuts 1974).

Cementum annulations

A detailed description of mammal tooth morphology and development was given by Spinage (1973). Permanent teeth consist of enamel, dentine and cementum, which all show certain lines when observed in section under a microscope.

Enamel is the outer coating of the crown of the tooth and is deposited before eruption. The lines of Retzius in the enamel are incremental lines and their formation has been attributed to a physiological calcification rhythm (Schour & Hoffman 1939). The Hunter-Shreger lines in the enamel are a series of alternating light and dark bands running longitudinally. They are the result of an optical phenomenon due to the prism arrangement of the enamel.

Dentine is the major tooth substance. At eruption little more than the crown of the tooth is formed and complete root formation occurs later. Deposition of secondary dentine starts even before eruption and continues until the pulp cavity is occluded, or nearly so. Secondary dentine also shows rhythmic deposition, portrayed by alternate light and dark bands, the contour lines of Owen, which run at an oblique angle to the tooth surface. Occasionally a finer pattern of incremental parallel lines may be seen, the lines of Von Ebner. Lines which result from variations in calcification and which run in the same direction as the contour lines of Owen are sometimes present. These lines are not incremental, however.

Cementum normally covers the root of the tooth. The cementum layer is thick in ungulates, but thin in rodents, carnivores and primates. The acellular cementum, adjacent to the dentine, is formed first and deposition of cellular secondary cementum is initiated when the tooth commences eruption. The cementum is deposited on the roots of the teeth by the fibrous layer of the periodontal membrane. Cementum accretion is probably continuous with disturbances such as cold winters or dry seasons causing interruptions in the process. This results in annulations in the cementum.

In old age, resorption of the tooth takes place, starting with the tip of the root. In extremely old animals the lower part of the dentine may also be resorbed. This process apparently results from an imbalance of calcium ions between the blood and calcified tissues and proceeeds rapidly once initiated (Spinage 1973). The roots of the teeth seem to be the first tissues drawn upon to correct this imbalance. This

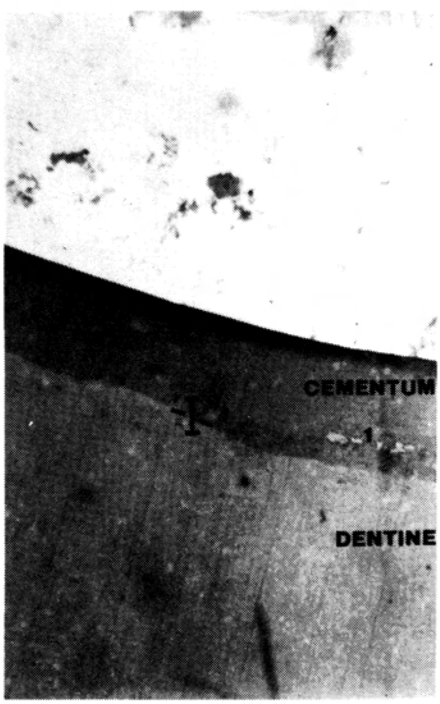


Fig.5. Longitudinal section of the cementum of the permanent first incisor of a *ca* five-year-old Cape mountain zebra (Fig. 4g) from the Mountain Zebra National Park. Note the single line in the cementum. (-I- denotes the interface between cementum and dentine).

implies that counts of the cementum annulations can only give the minimum age which an animal attained, as an unknown number of lines may have been resorbed.

In the present study, permanent first incisors of 17 Cape mountain zebra skulls were decalcified and sectioned. Layers were visible in the cementum of all of these. Longitudinal sections were made as this allowed layers to be traced over longer distances. This proved to be a boon where layers were indistinct. Best counts were obtained from the lingual surface of the incisor just above the terminal root boss, as also found in plains zebras (Smuts 1974). The permanent first incisors of Cape mountain zebras erupt at about 2,5 years of age and secondary cementum is deposited from then on.

In a *ca* four-year-old Cape mountain zebra, one line could be distinguished in the cementum (fig. 5), indicating two cementum layers. In a known-age six-year-old Cape mountain zebra, two lines and three cementum layers could be identified (fig. 6), exactly as expected. Eleven lines (therefore 12 layers) could be identified in an animal which was therefore estimated to be 15 years old (Fig. 7).

In the older animals the pattern of cementum lines generally became complicated and its was impossible to determine the age. Clear lines indicating ages up to 18 years could be counted, however.

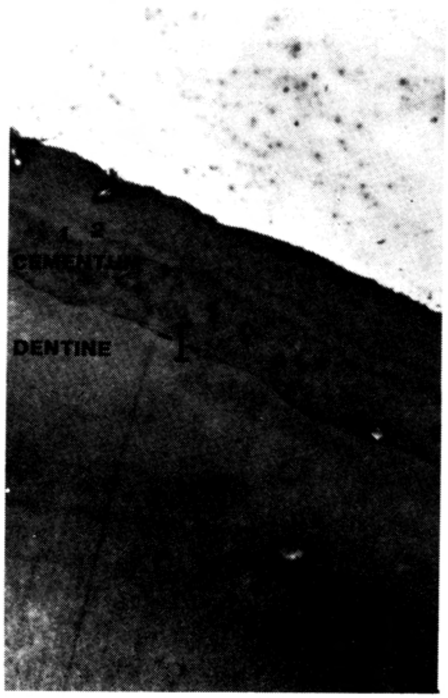


Fig. 6. Longitudinal section of the cementum of the permanent first incisor of a known-age six-year-old Cape mountain zebra (Fig. 4h) from the Mountain Zebra National Park. Note the two lines in the cementum. (-I- denotes the interface between cementum and dentine).

It may be stated in conclusion that cementum layer counts offer a reliable age determination method for Cape mountain zebras, at least up to 15 years of age and probably a few years more. The changing shape of the infundibulum in the incisors due to tooth wear may be reliable method, but age class criteria have not been defined for Cape mountain zebras on this basis, due to the paucity of material. The age class criteria defined for Hartmann zebras (Joubert 1972) do not hold true for Cape mountain zebras in the older age classes. Pursuing age determination methods further in the Mountain Zebra National Park population would serve no purpose, except for comparison with other populations, as the ages of virtually all of the individuals are known.

Acknowledgements

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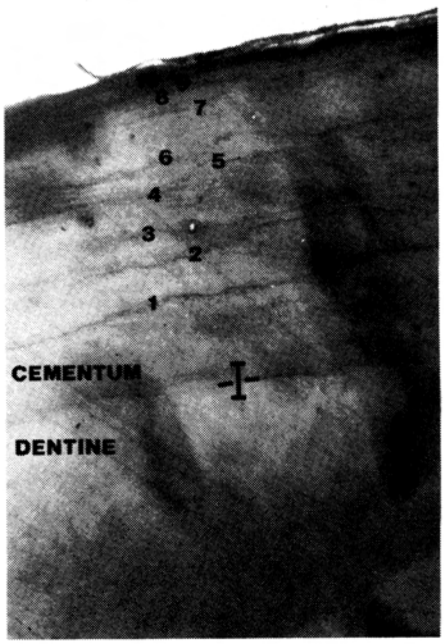

Fig. 7. Longitudinal section of the cementum of the permanent first incisor of a *ca* 15-year-old Cape mountain zebra stallion from the Kouga Mountains, southern Cape Province. Note the 11 lines in the cementum. (-I- denotes the interface between cementum and dentine).

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