mentioned female came in heat five weeks post partum so that the major time of the second pregnancy was already completed during the rearing of the first litter, and the rearing of two litters required about five and a half months. As this happened with punctual regularity, it is undoubtedly not an individual phenomenon but a general characteristic of northern weasels and to be interpreted as an adaption to the short summer of northern latitudes. Several captive females of the Central-European *M. n. vulgaris* did not come in heat until 9—10 weeks post partum, i. e. after the rearing of the young was fully completed. But the material is not sufficient for asserting their incapacity for a shortened litter sequence and for concluding a corresponding difference between the weasels of northern and temperate latitudes.

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Paradontal disease as a cause of tooth loss in a population of chamois *(Rupicapra rupicapra* L.) in New Zealand

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Introduction

Paradontal disease causes the gradual destruction of tissues surrounding the tooth in the alveolus and the alveolar bone tissue, causing loss of one or more teeth. It has been reported in man (Coolidge and Hine 1958), domesticated (MacKinnon 1959; Cohrs 1954) and wild mammals (Eidmann 1939; Stubbe 1965; Rudge 1970 and Niethammer 1971).

The pathological course of paradontal disease is divided into three main phases (Coolidge and Hine 1958). The first phase – primary marginal gingivitis – begins when chemical or mechanical irritants cause the gingival tissue to become inflamed. The epithelium in the inflamed area becomes traumatic and open to bacterial infection. The second phase — periodontitis – occurs when the infection in the gingival tissue gradually penetrates through the gingival sulcus into the periodontal tissues, thereby affecting the periodontal membrane that anchors the tooth in the alveolus. This stage is accompanied by resorption of the alveolar bone crest; it is aggravated by accumulation and compaction of foreign material such as food, sand and grit within the lesion. The third phase – alveolar ostitis – begins when the infection penetrates deeper into the alveolus, causing destruction and resorption of alveolar bone. The principal connecting fibres of the periodontal membrane are affected and, because of unbalanced periodontal tension, teeth migrate from their normal position causing misalignment of the occlusal surface. With progression of the disease, as the alveolar bone itself becomes grossly infected, these teeth continue drifting until finally they are rejected. Healing of the infected area then takes place in those animals which have not succumbed to the disease. The external alveolar bone swelling is gradually resorbed, and the alveolus becomes filled with granular tissue which

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results in the expulsion of accumulated foreign matter (mainly compacted food). Finally, continuity of the oral mucuous membrane is restored over the now healed and filled alveolus.

This report describes the occurrence and incidence of paradontal disease in a population of chamois collected in New Zealand during the early southern summer of 1965–66.

Material and methods

Five hundred and seventy chamois right mandibles (lower jaws) of both sexes were collected for demographic analyses from the Copland and Rangitata river catchments in the South Island, New Zealand (Caughley 1970). The age of the male and female components was determined from growth rings in the cementum at the root of the first incisor (Pkelharing unpublished) and, when this tooth was absent, from growth restrictions on the horns (Couturier 1938).

Mandibles of mature animals were examined for symptoms of paradontal disease. Only the periodontitis, the alveolar ostitis and the final healed phase could be recognised. Mandibles arrived in the laboratory in a dried condition so that the marginal gingivitis phase could not be detected. In addition, as some of the incisors and canines were lost during transport, the study was restricted to molariform teeth.

Characteristics of the early and later periodontitis phase, the alveolar ostitis phase and the final healed phase were identified as follows:
1. Resorption of the alveolar bone crest (Fig. 1a).
2. Swelling of the mandible at the site of the infection (Fig. 1b).
3. Misalignment of teeth (Fig. 1c), usually accompanied by perforation of the jaw (Fig. 1d).
4. Missing teeth with the jaw still swollen (Fig. 1e).
5. Missing tooth or teeth with the alveolus filled and completely healed and no visible swelling of the mandible (Fig. 1f).

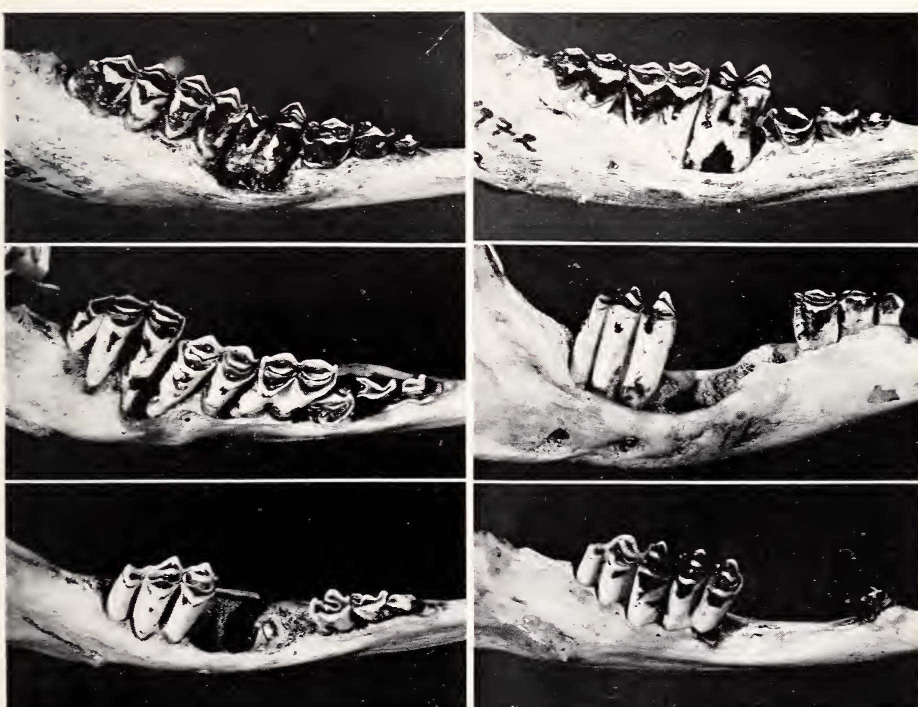

Fig. 1a—f. From left to right (Photographs by J. Burnip)

Results

Of the 570 chamois of both sexes and all ages collected, 274 animals (183 ♀♀; 91 ♂♂) were older than 36 months of age and therefore had a completely erupted permanent set of molariform teeth (COUTURIER 1938). Mandibles of these animals were examined for symptoms of paradontal disease. Twenty per cent (N = 56) were affected by the later phases of paradontal disease (19 % of the females, n = 34; and 24 % of the males, n = 22). No significant difference ($P < 0.05$) was detected between the proportions of animals of each sex affected by paradontal disease (G-test, SOKAL and ROHLF 1969).

To detect whether there was any difference in condition between diseased and healthy animals, males, pregnant and non-pregnant females were tested separately and age specifically by a two-factor, unbalanced analysis-of-variance. The two condition indicators tested were the kidney-fat-index (RINEY 1955) and the weight of the kidney without the fat (BATCHELER and CLARKE 1970).

Despite the fact that the means of the diseased animals were consistently lower in all three categories tested, this difference was not great enough to outweigh the natural variance within each indicator. This may be because the age and sex specific sample sizes of diseased animals were inevitably small. The table shows the frequencies of healthy and diseased animals of both sexes in each age class. The difference between the proportion of healthy and diseased animals in each age cohort was highly significant for females ($X^2 = 14.5$; d. f. = 4; $P > 0.01$) and significant for males ($X^2 = 11.05$; d. f. = 4; $P > 0.05$). Therefore, it can be concluded that with increasing age, proportionally more animals were affected by paradontal disease. This suggests that the duration of the disease from the initial marginal gingivitis phase (not detected in this study) through to the later periodontitis and alveolar ostitis phases may be a drawn out process. It also suggests that susceptibility to infection may increase with age.

Age	Preg. + Non-pregnant ♀♀			♂♂		
	Diseased	Healthy	% Dis.	Diseased	Healthy	% Dis.
3	6	64	9	1	26	4
4	6	42	13	3	17	15
5	7	19	27	2	8	20
6	4	15	21	2	7	22
7+	7	9	44	8	11	42
	30	149		16	69	
	4 diseased animals not aged			6 diseased animals not aged		

Figure 2 shows the frequency for both sexes of infected alveoli retaining teeth and alveoli with rejected teeth. It appears that teeth with the longest occlusal stress, that is those that erupt first[1], show a higher frequency of infection with paradontal disease, even though they are not necessarily rejected in that order. This pattern was similar in both sexes. Molars are obviously not as easily rejected as premolars because of their longer and sturdier root system. McCALL (1969) states that, in man, alveolar bone resorption caused by periodontitis will "first be seen around the teeth which erupt first; the first molar and the incisors". This is consistent with the above result.

[1] Eruption sequence of permanent lower molariform teeth in chamois; M_1 — M_2 — M_3 — [PM_2, PM_3, PM_4] (COUTURIER 1938).

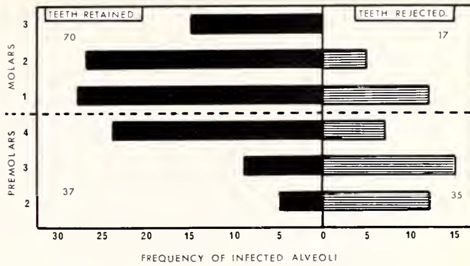

Fig. 2

The pathology of the disease in chamois is similar to the type description of periodontitis complex in man. In periodontitis simplex, bone is resorbed at an even rate around each tooth throughout the mouth and pockets are of even depth. In periodontitis complex, bone is resorbed unevenly in relation to individual teeth (Box 1921). Thus, pocket formation was localised and uneven in the alveolar tissues and around the infected tooth or teeth (see Fig. 1), and usually involved the first molar in both sexes. It was followed, in the early phases of alveolar ostitis by enlargement and deepening of the alveolus and accumulation of foreign matter. In the final phase loss of the tooth occurred.

Discussion

The frequency of animals infected by paradontal disease reported in this study is almost certainly an underestimate. This is because the primary marginal gingivitis phase could not be detected in the jaws of this sample; furthermore the study was restricted to molariform teeth in the lower right-hand jaws only. In several of these jaws molars were observed with abnormally elongated cusps, indicating an obvious gap in the maxillary toothrow.

There was no significant difference between the condition indices of diseased and healthy chamois in the sample studied. However, the extent of the damage caused to the alveoli of molars during the periodontitis and alveolar ostitis phases (see Figs. 1a, b, c and d) strongly suggests that animals affected by these later phases of paradontal disease were in the process of losing condition or would have lost condition. It is reasonable to assume that irritation during mastication causes reduced ingestion with a consequent lowering of the general condition. This assumption is supported by evidence given by MacKinnon (1959), and other reports published by Thompson (1906), Anon (1944), Murie (1944), Colyer (1947) and Coolidge and Hine (1958). However, the fact that some animals did survive the disease, although with a reduced dentition (see Fig. 1f) indicates that infection with paradontal disease is not necessarily fatal.

MacKinnon (1959) found no evidence in sheep of any generalised or other systemic disease (particularly of bone), and only the changes normally associated with falling condition and reduced intake of food. He also reported that in other cases of paradontal disease in sheep, he frequently observed the final healing phase after premolars had been rejected, but in the case of molars the animals usually had died or had been culled in an emaciated state before the repair process was complete. Rudge (1970) states however that in a population of feral goats on Macauley Island, Kermadec group, "the impact (of paradontal disease) on survival is not known but it probably was very slight, although it would certainly have been painful and affect chewing ability as age advanced".

Niethammer (1971) examined a sample of chamois skulls from New Zealand and concluded that both sexes show a greater dental variability than their ancestral Styrian counterparts. However, despite the fact that he observed symptoms associated with the later stages of paradontal disease, he did not consider that some of this apparent variability (i. e. anomalies such as missing teeth, see Fig. 1f) could be the result of a pathological condition, such as paradontal disease.

He further states that chamois teeth generally, appear to be exposed to heavier wear in New Zealand than in Styria. It is possible that the harder more fibrous nature of the vegetation occurring in the New Zealand alpine pastures has contributed significantly to faster attrition. This may also account for the relatively high frequency of animals affected by paradontal disease.

I have observed symptoms identical to those described in this report in red deer, fallow deer, sika deer and wapiti *(Cervus elaphus canadensis)*. However in these cervids teeth seldom appear to be rejected, probably because of their larger size and sturdier root system. In the opossum (*Trichosurus vulpecula* Kerr) the symptoms of paradontal disease were also apparent.

Poole and Newman (1971) state that diseases of the teeth and their supporting structures are more widespread in man than any other disease, and that paradontal disease is the principal cause of tooth loss. Evidence presented in this report indicates that this disease is probably more widespread in mammals than has generally been realised.

Summary

Suspected anomalies in the teeth of chamois were related to successive phases of paradontal disease. These phases were isolated in 20 % of a sample of 274 mature chamois mandibles of both sexes.

Permanent teeth with the longest occlusal stress were the first to be affected by the disease, they were not first to be rejected however. This appeared to be correlated with the morphology of the root system.

No significant difference in general condition could be detected between healthy and infected animals as determined from the kidney-fat-index and the weight of the kidney alone, although means of diseased animals were consistently lower.

The proportion of diseased animals increased with age in both sexes.

Zusammenfassung

Paradontale Erkrankungen als Ursache von Zahnverlust in einer Population von Gemsen in Neu-Seeland

Unregelmäßigkeiten im Gebiß neuseeländischer Gemsen wurden in bezug auf aufeinanderfolgende Phasen von paradontalen Erkrankungen gegliedert.

Verschiedene dieser Phasen wurden in 20 % einer Stichprobe von 274 voll ausgewachsenen Unterkiefern festgestellt.

Die Dauerzähne mit der zeitlich längsten okklusalen Belastung wurden von der Erkrankung zuerst ergriffen. Sie wurden aber nicht als erste abgestoßen, da diese Erscheinung sich eher auf den morphologischen Bau der Zahnwurzeln beziehen ließ.

Der allgemeine Zustand der gesunden und befallenen Tiere wurde durch das 'Nieren-Fett'-Verhältnis und das Nierengewicht beurteilt. Diese zeigten aber keinen gesicherten Unterschied, obwohl die Mittelwerte der befallenen Tiere etwas niedriger lagen.

Der Anteil befallener Tiere nahm in beiden Geschlechtern mit dem Alter zu.

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SCHRIFTENSCHAU

Hufnagl, E.: **Libyan Mammals.** 3 Karten. Harrow: The Oleander Press. 1972. 85 S., 93 Abb., £ 4,00.

Das vorliegende Buch gibt einen kurzen Überblick über die Hauptsäugetiere Lybiens, soll aber vor allem als Feldführer bei der Bestimmung von Säugetieren in der Natur dienen. Ein übersichtlicher Bestimmungsschlüssel nach äußeren Merkmalen macht dies zumindest für die Arten möglich, auf Unterarten wird nur bei deutlichen Unterschieden eingegangen. Die Abgrenzung wird durch zusätzliche Photos und Zeichnungen vereinfacht. Oft liegen auch Abb. der Schädel und Trittsiegel vor. Für jede Form werden die Kennzeichen, der Lebensraum, die Verbreitung mit Fundortangaben und weitere Informationen (Verhalten, Haltung im Zoo, historische Berichte, etc.) angegeben. — Neuere Arbeiten sind bereits bei der Systematik (z. B. *Gerbillus aureus*) und in der ausführlichen Bibliographie berücksichtigt.

Dem speziellen Teil sind zwei einleitende Kapitel über die paläontologische Säugetierfauna Lybiens und über die Verbreitung der rezenten Formen in historischer Zeit vorangestellt. Dabei wird erschreckend deutlich, wie stark der Mensch die Säugetierfauna in Lybien dezimiert hat, und wie notwendig eine Kontrolle der eingeleiteten Schutzmaßnahmen ist.

J. Lange, Stuttgart

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