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Tooth Eruption and Replacement in the Spanish Wild Goat

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Tooth eruption and replacement were studied in 99 Spanish wild goats (*Capra pyrenaica* Schinz, 1838) from two populations, one from Gredos Mountains and the other from the Cazorla and Segura Mountains. Comparison of sexes and of the two populations did not show significant differences. The eruption time (in months) of the permanent teeth in the mandible was M_1, from the first to second months; M_2 by the 13th month; I_1, 15th; M_3, PM_3 and PM_4 25th; I_2, 30th; PM_2, 30th—33rd; I_3, 35th—46th and finally, C by 48th—57th months. Results were compared with those from phylogenetically near species showing great similarity in general. The only notable difference with respect to most of the taxa considered was the delayed eruption of the permanent lower first premolar (PM_2) in the Spanish wild goat with respect to the other species.

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1. INTRODUCTION

The appearance and loss of the milk teeth, and the eruption of permanent teeth, occur in mammals following a determined order and in chronologic periods relatively independent of the animal's physiological state (Bourlière & Spitz, 1975). This fact has long facilitated age determination in the developmental stages of man and wild or domestic animals.

The object of this study was to identify the changes that take place in the dentition of the Spanish wild goat (*Capra pyrenaica* Schinz, 1838) a representative ungulate of the Iberian mountains whose distribution area includes the Pyrenees, Central Range and numerous southern and eastern mountains of the Iberian Peninsula (Fig. 1). Eruption sequence and replacement from birth to the attainment of the complete permanent dentition can be used to determine the age of individuals up to the age of 66 months.

2. MATERIAL AND METHODS

We studied 97 individuals, males and females, under 6 years age, captured throughout the year. Forty-two came from the Cazorla and Segura Mountains

(37°45′—38°10′ N and 2°40′—3°00′ W), 1980—1981, and 55 from the Gredos Mountains (40°11′—40°26′ N and 5°06′—5°20′ W), 1982—1983. We also examined 2 individuals born in captivity in the "Centro de Fomento y Mejora de la Fauna Silvestre" (Casa de Campo, Madrid), born on 17.5.1982, and dead on the 23rd and 29th the same month. The study was made with mandible and maxillary teeth of clean skulls.

Ages were calculated using May 15th as the average birth date (based in our own unpublished observations), knowing the date of death and counting the number of external horn rings in animals more than 1 year old (Couturier, 1961).

Fig. 1. Present distribution of the Spanish wild goat. 1 — Gredos Mountains; 2 — Cazorla and Segura Mountains.

To describe various dental stages (Table 3), the terminology of Henrichsen & Grue (1980) was used with some minor modifications: Pb symbols designate permanent and completely formed, but unworn incisors or canines (without the yellowish dentine line that usually appears in a worn tooth), and d-Eg symbolizes when the permanent tooth starts its eruption, with the corresponding milk tooth still in place.

3. RESULTS

We found no significant differences in the sequence and timing of tooth eruption and replacement with respect to either sex or geographical origin, so all specimens were grouped into a single sample.

The Spanish wild goat has a diphiodont dentition. Generally in neither of them no upper incisors nor canines are present. However, we encountered 5 specimens with upper canines (in two of them in both maxillae) and 10 with some indication that could denote their appearance (for example, an alveolus). Because of their position, these canines usually do not break the gum and cannot be seen until the skull is cleaned (Plate V, Phot. 2a).

3.1. Incisors and Canines

The two specimens observed in captivity showed incisors and canines as protuberances in the gum at birth, with the first pair of incisors beginning to show in one animal. In the 1 month old individuals, the three milk incisors and canine of each mandible were perfectly visible. This formula continued for the first 14 months of life (Plate IV, Phot. 1a—c). By the 15th month, the first permanent incisor (I_1) had begun to erupt. Between the 25th and the 30th months, the second milk incisor was replaced by the permanent tooth (I_2) (Phot. 1d—f).

Replacement of the third milk incisor presented the greatest variation. In every case the third milk incisor remained up to the 34th month. From 35 to 46 months the following variations were seen: (a) Milk tooth remained (d), (b) Permanent tooth began to show over the alveolus

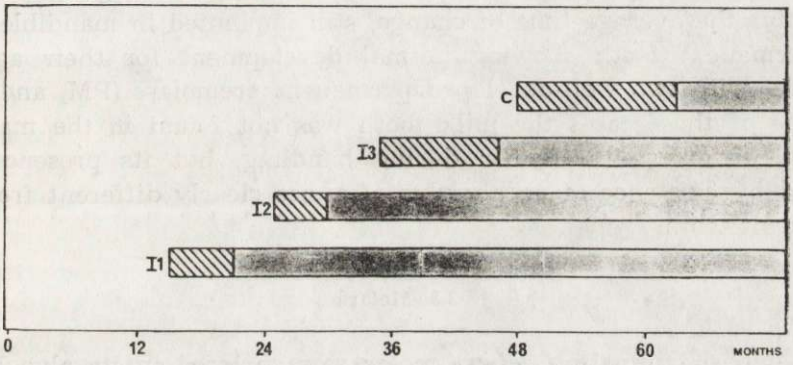

Fig. 2. Appearance periods of the definitive canines and incisors. Stripped bars: difinitive tooth occurs in some specimen pointed bars: every specimen bars the definitive tooth.

while the milk tooth remained (d—Eg), (c) Permanent tooth was completely formed (Pb) (Phot. 1g). Nevertheless, we found a third milk incisor in one 50 month specimen. Finally, the permanent canine (C) began to appear at the 48th month and after the 63rd month was completely formed in all the specimens studied (Phot. 1h and Fig. 2).

The third incisor was missing twice, in both instances on the right side of 51- and 66-month individuals).

3.2. Premolars

In specimens younger than two weeks, milk premolars appeared over the alveolus, but did not pass the gum line (observations from a newborn goat and two aged 6 and 12 days). When the goat reached is first month, milk premolars broke the gum and were completely developed

during the first months of life (Phot. 1,2a—d). The change of premolars took place in a shorter period than other teeth.

By the 25th month, the permanent PM_3, PM^3, PM_4 and PM^4 (PM^2 by 25th—27th months) began to emerge while their corresponding milk teeth still remained. By the 30th month they erupted completely and were finally formed by the 42 nd months (Phot. 1,2e—g).

In the mandible, the first premolar (PM_2) developed more slowly. The permanent tooth was present by the 27th month, but together with the milk tooth. Until the 34th month it did not emerge completely, terminating its formation in subsequent months (Plate V, Phot. 2f).

In some cases absence of a permanent PM_2 in the mandible was observed; in 3 cases (in both mandibles) neither PM_2 nor its corresponding alveolus were visible; in another case, it was missing only on the left side. There were also 8 cases in which the milk teeth (pm_2) persisted long after the average time of change, still implanted in mandibles with the permanent teeth showing normal development for their age, for example, with two well-developed permanent premolars (PM_3 and PM_4). In some of these cases the milk tooth was not found in the mandible because of loss naturally or during handling, but its presence was verified by existence of an alveolus of a size clearly different from the permanent tooth.

3.3. Molars

In newborn animals the first molar was enclosed in its alveolus; in the mandible, the molar protruded from the alveolus from the first month and in the maxilla, by the third month. Generally, by the 3rd month the first molar had erupted although in isolated cases breaking the gum may be delayed 1 or 2 months. The first molar terminated its development by the 15th month in the mandible and later in the maxilla: in our 21-month individuals it was completely formed (Phot. 1,2a—d).

The second molar began to appear in its alveolus by the 6th month in most cases and it commenced eruption by the 13th month in both mandible and maxilla, although it may appear some months earlier in the mandible. The process continued until the 15th month when the tooth was clearly above the gumline. There is an important difference between mandible and maxilla with respect to complete formation of the second molar; in the mandible it occurs in the 21st month and in the maxilla it is delayed until the 33rd—37th months (Phot. 1,2c—f).

The third molar was observed in mandibles of 21-month old individuals. It began to protrude from the alveolus by the 25th month in the mandible and maxilla; although there are slower cases, in the maxilla, for

example, 30 months. From the 27th to 30th months erupted in the mandible and its complete development took from several months to two years (39—54 months). Development was considered to be finished when the external anterior edge of the hypoconulid was fused to the second lobe completely.

These processes usually took somewhat longer in the maxilla: from the 34th to 37th months M^3 broke the gum, finishing its formation from the 49th to 54th month (here coinciding with its mandibular homologue). Development concluded with fusion of the layers of enamel in the centre of the distal aspect (Phot. 1,2e—h).

3.4. Sequence and Times of Tooth Eruption

To establish the eruption order of the permanent dentition, mandibles and corresponding maxillae were examined from individuals with incomplete dentition, 76 of the 99 skulls available. The two goats born in captivity were not considered.

Table 1 compares the presence of particular teeth to absence of the rest. A tooth was considered "present" when it surpassed the upper edge of the alveolus. Two kinds of results are shown: presence of a particular tooth with respect to the total cases studied (76) and ratio between the number of cases in which a tooth was present and the corresponding tooth studied was absent. Once these data were obtained, the Table was arranged according to the calculated percentage value. The resulting eruption sequence heads the first row:

M_1, M^1, M_2, M^2, I_1, (PM_3, PM_4, PM^3, PM^4, M_3), (M^3, PM^2), I_2, PM_2, I_3, C

Teeth with the same value, denoting simultaneous appearance, are grouped in parenthesis. For example, in 67.1% cases M_1 protruded from the alveolus while the third incisor was absent, or 51 individuals presenting M_1 out of 54 with the I_3 absent.

There were a few specimens (non-zero values below the diagonal) in which eruption of a particular tooth with respect to another was delayed. Such was the case of PM_2; in 40 cases in which it was absent, I_2 had appeared 4 times, therefore, the second incisor was anterior in the sequence. However, in 37 cases where I_2 was absent, PM_2 was present once, but this was considered an isolated delay that could be attributed to any of the factors affecting the animal's development.

In Table 2 the specimens studied were divided into different age classes, registering the percentage of animals in each group as compared to the total (76) that presented a particular tooth (from Eg). Age classes

Table 1

Ratio between the number of cases in which a tooth is present and the permanent tooth in 76 mandibles and

ABSENCE ↓	PRESENCE → M_1	M^1	M_2	M^2	I_1	(PM_3	PM_4
C	73/76 96.0	71/76 93.4	56/76 73.7	53/76 69.7	49/76 64.5	44/76 57.9	44/76 57.9
I_3	51/54 67.1	49/54 64.5	34/54 44.7	31/54 40.8	27/54 35.5	22/54 28.9	22/54 28.9
PM_2	37/40 48.7	35/40 46.0	20/40 26.3	17/40 22.4	13/40 17.1	8/40 10.5	8/40 10.5
I_2	34/37 44.7	32/37 42.1	17/37 22.4	14/37 18.4	10/37 13.2	5/37 6.6	5/37 6.6
PM^2	31/34 40.8	29/34 38.2	14/34 18.4	11/34 14.5	7/34 9.2	2/34 2.6	2/34 2.6
M^3	31/34 40.8	29/34 38.2	14/34 18.4	11/34 14.5	7/34 9.2	2/34 2.6	2/34 2.6
M_3	29/32 38.2	27/32 35.5	12/32 15.8	9/32 11.8	5/32 6.6	0	0
PM^4	29/32 38.2	27/32 35.5	12/32 15.8	9/32 11.8	5/32 6.6	0	0
PM^3	29/32 38.2	27/32 35.5	12/32 15.8	9/32 11.8	5/32 6.6	0	0
PM_4	29/32 38.2	27/32 35.5	12/32 15.8	9/32 11.8	5/32 6.6	0	
PM_3	29/32 38.2	27/32 35.5	12/32 15.8	9/32 11.8	5/32 6.6		0
I_1	24/27 31.6	22/27 28.9	6/27 7.9	4/27 5.3		0	0
M^2	20/23 26.3	18/23 23.7	3/23 3.9		0	0	0
M_2	17/20 22.4	15/20 19.7		0	0	0	0
M^1	2/5 2.6		0	0	0	0	0
M_1		0	0	0	0	0	0

corresponding tooth studied is absent, and percentage of presence of a maxillae with incomplete dentition.

PM^3	PM^4	M_3)	(M^3	PM^2)	I_2	PM_2	I_2	C
44/76 57.9	44/76 57.9	44/76 57.9	42/76 55.3	42/76 55.3	39/76 51.3	36/76 47.4	22/76 28.9	
22/54 28.9	22/54 28.9	22/54 28.9	20/54 26.3	20/54 26.3	17/54 22.4	14/54 18.4		0
8/40 10.5	8/40 10.5	8/40 10.5	6/40 7.9	6/40 7.9	4/40 5.3		0	0
5/37 6.6	5/37 6.6	5/37 6.6	4/37 5.3	4/37 5.3		1/37 1.3	0	0
2/34 2.6	2/34 2.6	2/34 2.6	2/34 2.6		1/34 1.3	0	0	0
2/34 2.6	2/34 2.6	2/34 2.6		2/34 2.6	1/34 1.3	1/34 1.3	0	0
0	0		0	0	0	0	0	0
0		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

Table 2

Percentage of individuals in each age class with a determinate tooth erupted (from Eg).

Age, months	M_1	M^1	M_2	M^2	I_1	PM_3	PM_4	PM^3	PM^4	M_3	M^3	PM^2	I_2	PM_2	I_3	C
0— 3	70	50														
4— 8	100	100	0													
9—11			16.7	0	0											
12—18			100	77.8	33.3	0	0	0	0	0	0	0	0			
19—25				100	100	60	60	60	60	60	60	20	20	0		
26—31						100	100	100	100	100	66.7	100	50	33.3	0	
32—36											100		100	80	20	
37—40														100	44.4	
41—47															78.6	0
48—53															85.7	14.3
54—57															100	80
58—61																100

were defined according to periods in which important dental changes happened. As can be seen in Table 2, there was a delay in the appearance of the upper molars with respect to their mandibular homologues. In the premolars the 3rd and 4th maxillary and mandibular teeth appeared simultaneously, while the lower first premolar (PM_2) emerged later.

Permanent incisors and canines began to erupt between the 12th and 18th months (I_1) and the 4 permanent teeth of each mandible were present by the 58th—61st month (the canine was the last to appear). The period of molar appearance was much shorter; M_1 appeared from 0 to 3 months (it was the first to appear in the series) and M_3 from the 32nd to 36th months. The shortest period was that of premolars. Between the 19th and 25th months appeared PM_3, PM_4, PM^3, PM^4 and PM^2, and finally PM_2 between the 26th—31st months.

Table 3 shows the development of each tooth from its presence in the alveolus (Ea) or appearance of the milk tooth to complete formation of the permanent tooth (P). The first permanent tooth to complete formation was the first molar, which was completely shaped by the 21st month, and the last one was the canine, which was not definitively shaped until the 66th month in all cases. The permanent dentition is considered to be completely developed by the 4th year excepting the canine whose emergence and later development extended throughout the 5th year of life.

4. DISCUSSION

The milk and permanent dentition of the Spanish wild goat resemble, for the main part, *Bovidae* in general features such a number and shape. This fact permits comparison of sequences and eruption times between different genera. In Table 4, data obtained in this study of the Spanish wild goat are contrasted with data of 7 caprines derived from available bibliography. Caughley (1965) observed that first molar is the earliest permanent tooth to emerge in 6 species of *Bovidae* and in one of *Antilocapridae*. It is usually followed by the 2nd molar and 1st incisor, then the 3rd molar, 2nd incisor and premolars, completing permanent dentition with the 3rd incisor and canine. The order resembles the sequences given in the Table 4.

Compared with the other two species of *Capra* cited, many similarities can be apprecied, excepting the sequence of appearance of 2nd incisor and first premolar (PM_2), both later in *Capra pyrenaica*, and the eruption time of the canine, appearing in the 4th year in both the ibex (*Capra aegagrus ibex*) and domestic goat (*Capra hircus*). However, general features are constant, such as the prior eruption of mandibular teeth

Table 3

Eruption pattern of mandibular and maxillary teeth.

dEg: milk tooth emerging, (d) milk tooth already shaped; (d-Eg) definitive tooth starts its eruption, with the corresponding milk tooth still in place; (Ea) definitive tooth internal (it does not pass the alveolus); (Eg) definitive tooth appearing (it present some parts of the crown above the alveolar edge, but still unstained);(E) definitive tooth with some parts of the crown stained (this happens when the tooth surpasses the gum line but it is not completely shaped); (Pb) definitive incisor or canine completely shaped, but unworn (without the yellowish dentine line that usually appears in a worn tooth); (P) permanent tooth completely formed, and entirely stained from the gum line.

Age, months	I_1	I_2	I_3	C	PM_2	PM_3	PM_4	PM^2	PM^3	PM^4	M_1	M_2	M_3	M^1	M^2	M^3
0	dEg	dEg	dEg	dEg	dEg	dEg	dEg	dEg	dEg	dEg	Ea	⊢	⊢	Ea	⌊	—
6	d	d	d	d	d	d	dE	d	dE	dE	E	—/Ea	—	E	—/Ea	⌊
13	d	d	d	d	d	d	d	d	d	dE/d	E	Eg/E	⊢	E	Ea/Eg	⊢
21	Eg/P	d	d	d	d	d	d	d	d	d	P	E/P	—/Ea	P	E	—
24	P	d	d	d	d	d-Eg	d-Eg	d	d-Eg/Eg	d-Eg/Eg	P	P	Eg	P	E	Ea/Eg
30	P	Ea/P	d	d	d/Eg	E	E	E	E	E	P	P	E	P	E	Ea/Eg
36	P	P	d/Eg	d	E/P	E/P	P	E	E	E	P	P	E	P	E/P	Ea/E
42	P	P	d/Pb	d	P	P	P	E/P	E/P	E/P	P	P	E/P	P	P	E
48	P	P	Pb/P	d/E	P	P	P	E/P	P	P	P	P	E/P	P	P	E
54	P	P	P	d/Pb	P	P	P	E/P	P	P	P	P	P	P	P	E/P
60	P	P	P	Eg/Pb	P	P	P	P	P	P	P	P	P	P	P	P
66	P	P	P	Pb/P	P	P	P	P	P	P	P	P	P	P	P	P

Table 4

Eruption order and age at appearance of each permanent mandibular tooth in some representatives of *Caprinae*.

Species and origin	Eruption order and age at appearance of the tooth (in months)											References
Capra pyrenaica (Spain)	M_1 1—2	M_2 13	I_1 15	(M_3	PM_3 25	PM_4)	I_2 30	PM_2 30—33	I_3 35—46	C 48—57		Present study
Capra hircus (Spain)	M_1 3	(M_2 12	PM_2)	I_1 12—18	M_3 18—24	(PM_3 24	PM_4)	I_2 20—30	I_3 36	C 48		Romagosa (1975)
Capra aegagrus ibex (France)	M_1 4—5	(M_2 15	I_1)	I_2 28	M_3 28—39	(PM_2	PM_3 28—30	PM_4)	I_3 31—36	C 40—45		Couturier (1962)
Hemitragus jemlahicus (New Zealand)	M_1 2—3	M_2 9½—13½	I_1 14½—19½	(M_3	I_2) 24½—27½	PM_3 26½—32½	(PM_2	PM_4) 26½—33½	I_3 36½—47½	C 54½—74½		Caughley (1965)
Ovis aries	M_1 3	M_2 9—12	I_1 12—18	(M_3	PM_2	PM_3 18—24	PM_4	I_2)	I_3 30—36	C 42—48		Sisson & Grossman (1933)
Ovis aries (Spain)	M_1 3	M_2 8—10	I_1 12	(PM_2	PM_3 18	PM_4)	M_3 19—24					García-González (1980)
Ovis ammon musimon (Corsica)	M_1 6—8	(M_2 12—18	I_1)	(M_3	PM_2 24—30	PM_3	I_2)	(PM_4	I_3) 36—42	C 48—54		Pfeffer 1967
Ovibos moschatus (Greenland)	M_1 6	M_2 12	I_1 24—30	M_3 30	I_2 30—36	(PM_2	PM_3 36—48	PM_4)	I_3 48	C 48—54		Henrichsen & Grue (1980)
Rupicapra rupicapra (France)	M_1 4	(M_2 16	I_1)	I_2 28	(M_3	PM_2 32	PM_3	PM_4)	I_3 40	C 44		Pflieger (1982)
Rupicapra rupicapra (Europe)	M_1 4—5	I_1 16	M_2 16—17	I_2 28	M_3 28—30	I_3 32—38	C 35—40					Knaus & Schröder (1975)

with respect to maxillary teeth, and the order of appearance, with the exception of I_2 and PM_2, coinciding with most of *Bovidae*. This analogy between wild and domestic species of the genus has been mentioned by other authors. Deming (1952) likewise finds some evidence of similarities between domestic and wild species of the genus *Ovis* in North America.

Nevertheless, some differences exist, such as those indicated although they may derive from variation in the criteria for judging tooth appearance. We considered that the tooth had appeared when it protruded from the alveolus.

The different sequence and delay of the first premolar (PM_2) could be related to the tendency of this definitive premolar to disappear in the mandible. Perhaps this hypodontia can be explained by its lack of function in mastication; when the mandible and maxilla are joined the premolar is anterior, not making contact with any maxillary tooth. Since mastication in the wild goat does not show backward-forward movements, lack of PM_2 would be explicable.

Loss of PM_2 has been reported in Dall sheep, *Ovis dalli* (Hemming,, 1969), in mule deer, *Odocoileus hemionus* (Short & Short, 1964), white-tailed deer, *Odocoileus virginianus* (Mech *et al.*, 1970 and Feldhamer &

Table 5

Age determination in the Spanish wild goat: young individuals attaining their stage of the eruption sequence.

$i_1+i_2+i_3+c+$	M_1	1st year
	M_1+M_2	2nd year
$I_1+i_2+i_3+c+M_1+M_2$		2nd year
$I_1+I_2+i_3+c+$	$M_1+M_2+M_3$ (E)	3rd or 4th year
	$M_1+M_2+M_3$ (P)	4th year
$I_1+I_2+I_3+c+$	$M_1+M_2+M_3$ (E)	4th year
	$M_1+M_2+M_3$ (P)	5th year
$I_1+I_2+I_3+C+M_1+M_2+M_3$		5th year or more

Chapman, 1980) and in roe deer, *Capreolus capreolus* (Meyer, 1977). Other teeth are reported absent, including one incisor (Robinette, 1958, in deer; Chapman & Chapman, 1970 in fallow deer; Henrichsen, 1982, in muskox; etc.).

With regard to hypodontia of incisors or canines, we consider that the incisor which disappeared in our two cases was the 3rd, based on morphology, development and root orientation of those remaining.

Concerning the appearance of an upper canine, which is a reappearance of a tooth eliminated during evolution, there are data of its occasional existence in different *Cervidae*. Observations of various authors were collected from Virginian or white-tailed deer (*Odocoileus virgnianus*). Values are: 3.4% of 325 observations (Van Gelder & Hoffmeister, 1953); 17.9% of 162 (Knowlton & Glazener, 1965 in Steele & Parama, 1979), and 10.2% of 45 (Krausman, 1978 in Steele & Parama, 1979). We found 14.4% in 99 individuals under 6 years. The reason for these dental anomalies is interpreted according to different criteria. Genetic causes (Henrichsen, 1982) have been argued, based in studies made in different localities, and environmental causes have been suggested as well (Short & Short, 1964).

Ages of young wild goats are determined in Table 5 according to the number and stage of incisors, canines and molars, omitting premolars because they have been proven useless for this purpose. This Table facilitates exact age (years) estimation in 81.8% of the cases studied. The ages of 3 and 4 years were not clearly deducible in every case due to the variations that exist in the 3rd molar, as was indicated in results. These results should reaffirm the theory held by Bourlière & Spitz (1975) that age determination by dental development gives excellent results in ungulates.

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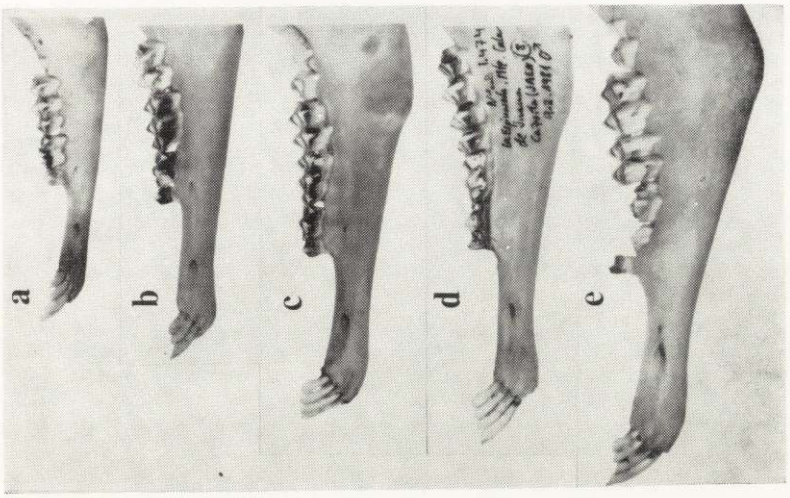
WYRZYNANIE SIĘ I WYMIANA ZĘBÓW U KOZIOROŻCA PIRENEJSKIEGO

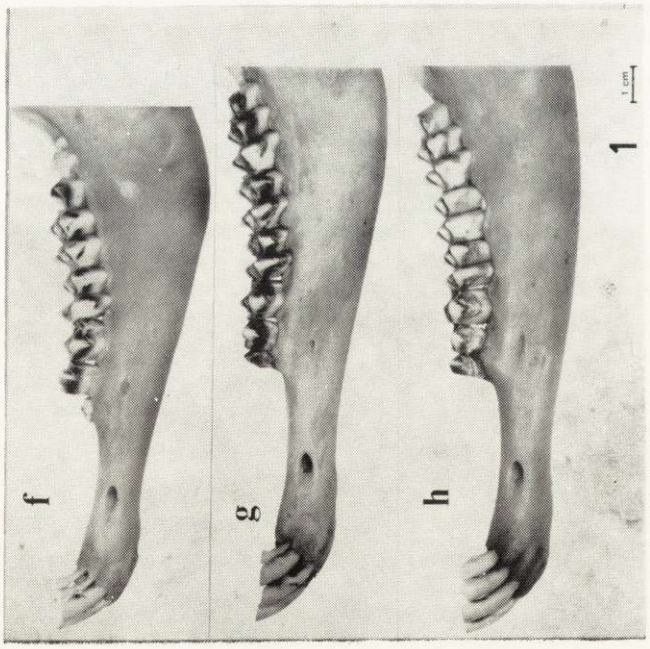
Streszczenie

Badania prowadzono na 99 *Capra pyreneica* Schinz, 1938, pochodzących z dwóch populacji — jednej z gór Gredos, a drugiej z gór Cazorla i Segura (Ryc. 1). Porównanie przeprowadzone między tymi populacjami i między płciami nie wykazało istotnych różnic. Okres wyrzynania się (w miesiącach) zębów stałych w żuchwie wynosił: M_1 — od jednego do dwóch miesięcy; M_2 — do 13 miesiąca; I_1 — do 15 miesiąca; M_3, PM_3 i PM_4 — do 25 miesiąca; I_2 — do 30 miesiąca; PM_2 — od 30 do 33 miesiąca; I_3 — od 35 do 46 miesiąca i C od 48 do 57 miesiąca (Tabela 1, 2, 3; Ryc. 2, 3). Wyniki porównano z okresem wyrzynania się zębów u gatunków filogenetycznie bliskich i uzyskano ogólnie duże podobieństwo (Tabela 4). Jedyna znaczniejsza różnica zawiera się w tym, że pierwszy dolny stały ząb przedtrzonowy u koziorożca pirenejskiego wyrzyna się później niż u wszystkich porównywanych gatunków (Tabela 5).

EXPLANATION OF PLATES IV—V

Photos 1 and 2. Dentition of Spanish wild goat of various ages. Mandibular teeth (1) of eight goats (a—h) and maxillar teeth (2). (a) One month. Note the presence of maxillary canines, (b) Six months, (c) Thirteen months, (d) Twenty-one months, (e) Twenty-five months. Permanent PM^2 beginning to erupt while their corresponding milk teeth still remained, (f) Thirty months. Note the delayed eruption of the permenent lower first premolar (PM_2) with respect to the other premolars, (g) Forty-two months. The first mandibular premolar (PM_2) is rotated (h) Sixty-three months. Both sides of the jaw present rotation of the second maxillary premolar (PM^3).





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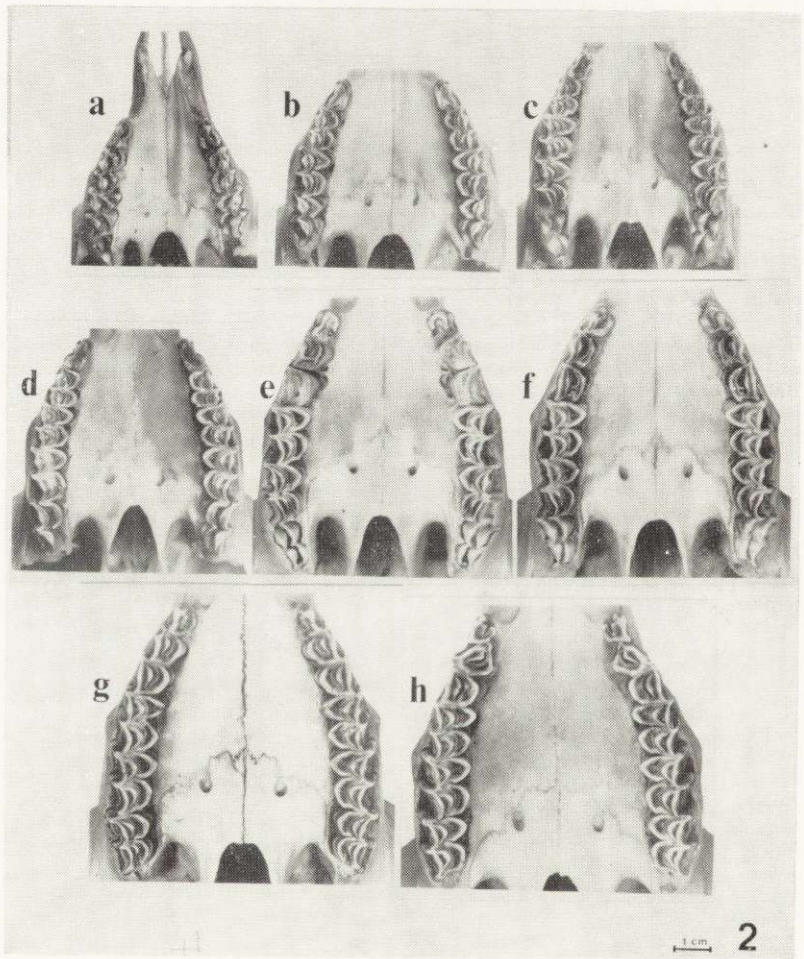

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