Reproductive characteristics of a free-ranging population of Cape mountain zebra (*Equus zebra zebra*)

B. L. Penzhorn

Department of Genesiology, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, Onderstepoort 0110, Republic of South Africa

Summary. In a population of free-ranging Cape mountain zebra, median age at first foaling was 67 months (range 38–105 months), median foaling interval was 25 months (range 13–69 months) and annual foaling rate was 32%. Foaling rates of younger and older mares were similar. Foals were born all year round with a peak corresponding to the rainy season (summer). Conception occurred later in the season when the spring was dry.

Introduction

The members of the free-ranging population of Cape mountain zebra (*Equus zebra zebra*) in the Mountain Zebra National Park (MZNP) are individually known. Records of reproductive performance of each mare can therefore be kept. Reproductive data of free-ranging equid populations may be useful for comparison with breeding of domestic horses (*E. caballus*). Despite intensive management, mean conception rates of domestic horse mares are 60–70%, with a foaling rate (live foal at 6 weeks) of about 60% (Rowlands, 1981). There are indications that breeding regimens which closely approximate the situation in free-living equids may give the best results (van Rensburg & van Heerden, 1953; Belonje, 1956; Bristol, 1982). Conversely, the ecology of free-ranging populations with low reproductive rates might offer clues to the identification of limiting factors.

The MZNP is situated near Cradock in the Midland Division, Cape Province, Republic of South Africa (32°15'S, 25°41'E). The initial population had died out by 1950, when 11 mountain zebras were donated to the MZNP by a neighbouring farmer. The first foal was born in February 1953 and records of foaling dates have been kept since then. In 1964 the MZNP was enlarged to 65.36 km² (6536 ha) and the purchase of 30 Cape mountain zebras on one of the farms increased the population in the MZNP to 55. The records of 16 subsequent foaling seasons were analysed to ascertain possible correlation between precipitation and the foaling season. Monthly distribution of births, age at first foaling, foaling interval and minimum age at last foal were also determined. Annual foaling rate, based on records of reproductive success of individual mares, could also be calculated. Surviving foals only could be recorded and the figures mentioned here therefore represent minimum values.

Materials and Methods

The characteristic stripe patterns of zebras facilitate individual recognition even in quite large populations (Penzhorn, 1984a). All the zebras in the MZNP population could be recognized in the field with the aid of photographs. Records were kept of the composition of each herd and the births of foals were noted. The birth dates of most foals were known fairly accurately. Herds which inhabit the more rugged and remote parts of the MZNP were encountered less frequently and

months sometimes elapsed between sightings. The approximate age of a foal and hence its month of birth could be estimated by comparing its size relative to its dam (Penzhorn, 1982a). Reproductive records of individual mares have been kept since 1971 and data up to the 1981/82 foaling season are included here. Ages of foals at foot in 1971 were estimated, extending the records of reproductive performance of some mares to 12 or 13 foaling seasons. The foaling season in which a mare turned 3 years old was regarded as the first in which foaling could be expected.

A foaling season was defined as the period 1 July to 30 June the following year. This includes the austral summer, which was defined as the 6-month period from October to March when the mean maximum temperature exceeded 20°C and 72% of the annual precipitation occurred. Winter was defined as the 6-month period from April to September when the mean maximum temperature was below 20°C and only 28% of the annual precipitation occurred. Snowfalls occurred 3–5 times each winter. Precipitation was measured at the MZNP headquarters in a standard rain-gauge supplied by the Weather Bureau. Mean monthly precipitation over 20 years (1 July 1962–30 June 1982) was calculated.

Results

All values stated here are based on observation only, and therefore probably underestimate the actual figures for the MZNP population.

Reproductive lifespan

Cape mountain zebra mares in the MZNP were recorded as foaling for the first time at a median age of 67 months (range 38–105 months) (Text-fig. 1). The gestation period of Cape mountain zebras has not been determined, but is assumed to be about 12 months. A mare running with a feral donkey (*E. asinus*) stallion gave birth to a hybrid foal 374 days after capture (Penzhorn, 1984a). The duration of pregnancy of a domestic horse mare in foal to a donkey stallion is some 15 days longer than if she is mated to a horse (Hammond, Mason & Robinson, 1971). If the same applies to mountain zebras, the normal gestation period would be ≥ 359 days. In conspecific Hartmann zebras (*E. zebra hartmannae*) a gestation period of 364 days has been reported (Joubert, 1974) and a foaling interval of 375 days was observed in a captive mare (Penzhorn, 1975). Therefore, the Cape mountain zebra mare foaling at 38 months probably conceived at about 26 months of age.

Text-fig. 1. The age at first foaling of 29 Cape mountain zebra mares in the Mountain Zebra National Park (median 67 months).

The minimum ages at which 3 old mares had their last foals were known. One was ≥ 17 years old. The second was ≥ 19 years old and lived a further 5 years. The third was ≥ 21 years old and lived a further 2.5 years.

Reproductive performance

The foaling intervals of 49 Cape mountain zebra mares, some foaling up to 6 times during the study period, were recorded. The median foaling interval was 25 months (range 13–69 months) (Text-fig. 2). The foaling intervals of mares known to be 13 years and older were compared to those of younger mares. The difference was insignificant (Wilcoxon's signed-rank test, $Z = -1.2028$).

Text-fig. 2. The foaling intervals of 49 Cape mountain zebra mares (100 foals born) in the Mountain Zebra National Park (median 25 months).

Table 1. Foaling record of 82 free-ranging Cape mountain zebra mares observed between 1 and 13 years

Mares		Number of foals born/mare							
No. of years observed	No. of mares observed	0	1	2	3	4	5	6	7
1	8	7	1	—	—	—	—	—	—
2	8	4	3	1	—	—	—	—	—
3	4	1	3	—	—	—	—	—	—
4	4	1	1	2	—	—	—	—	—
5	1	—	1	—	—	—	—	—	—
6	8	—	2	4	1	1	—	—	—
7	9	—	2	1	5	1	—	—	—
8	11	—	1	4	5	1	—	—	—
9	9	—	4	1	3	1	—	—	—
10	4	—	—	2	2	—	—	—	—
11	11	—	1	—	3	5	1	1	—
12	4	—	—	—	—	3	—	1	—
13	1	—	—	—	—	—	—	—	1

The reproductive records of 82 mares observed between 1 and 13 years are shown in Table 1. In a total of 559 mare years 178 foals were born, giving 0.32 foal/mare/year (or a foaling rate of 32%).

Foaling season

The births of 306 Cape mountain zebra foals were recorded during the 30 years from 1 July 1952 to 30 June 1982. The monthly distribution of births and mean monthly precipitation are shown in Text-fig. 3. Over the 30-year period the same number of foals (153) was born during the two 6-month periods (July–December and January–June) respectively. As the gestation period is taken to be about 1 year, Text-fig. 3 also illustrates the monthly distribution of conceptions. Significantly more foals were born during summer than in winter (213 vs 93; $\chi^2 = 47.0588$; $df = 1$; $P < 0.01$). The foaling peak therefore corresponds with the rainy season. The 6-month period with the highest mean precipitation is November–April, with 74.3% of the annual total: 210 foals were born during

Text-fig. 3. Monthly distribution of the births of 306 Cape mountain zebra foals (histogram) and the mean monthly precipitation recorded in the Mountain Zebra National Park (line).

these months. The 6-month period with the greatest number of foals was September–February, with 215 foals born.

Precipitation and the foaling season

The same number of foals was born early or late during the 30 foaling seasons considered. During some years the majority of foals was born early while in others the majority was born late. The number of foals born during the first and second halves of the foaling seasons July 1966–June 1982 and the precipitation recorded during the first half of the previous season are shown in Table 2. A one-tailed test of hypergeometric distribution in a 2×2 contingency table based on these data

Table 2. The precipitation recorded in the Mountain Zebra National Park during the first half of the foaling season and the number of Cape mountain zebra foals born during the next foaling season

Year	Precipitation (July–Dec.) (mm)	Dry spring*	Next season's foal crop†		Foals late‡
			Born July–Dec.	Born Jan.–June	
1965	166.9	No	10	3	No
1966	35.5	Yes	5	6	Yes
1967	67.0	Yes	10	9	No
1968	134.0	No	15	3	No
1969	95.7	Yes	9	11	Yes
1970	192.5	No	14	11	No
1971	251.5	No	5	4	No
1972	35.5	Yes	3	15	Yes
1973	97.5	Yes	9	7	No
1974	161.0	No	8	5	No
1975	190.9	No	8	4	No
1976	143.5	No	14	10	No
1977	168.5	No	9	1	No
1978	105.0	Yes	9	12	Yes
1979	187.0	No	4	9	Yes
1980	81.5	Yes	0	14	Yes

* Precipitation during July–December less than the mean of 130.5 mm.

† The 12-month period starting on 1 July of the following year.

‡ Fewer than half of the season's foal crop born during the first 6 months (July–December).

was carried out. Low precipitation during the first half of the foaling season was associated with the majority of conceptions occurring during the second half of the season, while high precipitation was associated with a majority of early conceptions ($0.95 \leq P \leq 0.98$).

No correlation between total precipitation during the season that conception took place and the size of the subsequent foal crop could be demonstrated. The size of the foal crop varied from 9 to 25, with no evident pattern. Good foal crops were often followed by small ones, irrespective of the rainfall.

Discussion

The minimum age at first foaling (38 months) agrees with that reported for other equids (King, 1965; Klingel, 1969; Joubert, 1974; Smuts, 1976). Cape mountain zebra fillies leave their maternal herds at a mean age of 21.85 months and are often in oestrus at the time (Penzhorn, 1984a). Most New Forest pony mares first foal at 4 or 5 years or even later (Pollock, no date). In the Kruger National Park all 3.5-year-old plains zebra (*E. burchelli*) mares in the sample were found to have ovulated, with a conception rate of 73.3% (Smuts, 1976). The mean age at first foaling in that population would probably be 4–5 years. The MZNP figure compares favourably with that for other wild and feral equid populations.

The reproductive lifespan of the MZNP mares agrees with that reported for other equids (King, 1965; Veselovsky & Volf, 1965). A captive Hartmann zebra mare foaled when 24 years old (Penzhorn, 1975). No evidence of reproductive senescence was found in free-living plains zebra mares (Smuts, 1976). Fertility of domestic horse mares gradually declines after 13–14 years of age (Hughes, 1980), but foaling rates of younger and older Cape mountain zebras are similar.

The median foaling interval of MZNP mares is similar to that reported for Hartmann zebra mares (Shortridge, 1934). The mean foaling interval of 6 captive Hartmann zebra mares was 544 days (~18 months) (Penzhorn, 1975). Only MZNP mares that foaled at least twice were included in these data: 13 mares were not recorded as foaling and 19 foaled once only (Table 1). The reproductive success of individual mares varied markedly: one mare produced 7 foals in 13 years, while another was recorded as foaling once only in 11 years. One mare had 4 foals in 7 years, followed by 5 barren years until her death at ≥ 24 years.

The annual foaling rate of feral ponies on the northern part of Assateague Island National Seashore, Maryland, U.S.A. was 61.4%. On the southern part of the island, where mares do not have to suckle the previous summer's foals through the winter, a 4-year mean foaling rate during the same period was 74.4% (Keiper, 1979). Frequency of suckling by Cape mountain zebra foals decreases to 1–3 bouts per day at 10 months of age and weaning often takes place at this time (Penzhorn, 1984a). This relieves the lactational stress on the mare. In the Ngorongoro Crater, Tanzania, 120 plains zebra mares observed over 3 years produced 0.51 foal/mare/year (calculated from data given by Klingel, 1969). This figure represents surviving foals only. There are numerous predators in the Crater (Kruuk, 1972) and some of the newborn foals probably fell prey to these before they were recorded. There are no large predators in the MZNP.

Feral domestic horse stallions displacing herd stallions force the mares to submit to copulation, leading to the loss of pregnancies of <180 days (Berger, 1983). The social system of mountain zebras is the same as that of feral horses (Penzhorn, 1984a) and a similar situation may be present in mountain zebras, which would adversely affect the foaling rate. Six mountain zebra herd stallions were displaced during a 3-year observation period. None of the 17 mares in the 6 herds foaled within 12 months of the take-over by the new stallion. With an annual foaling rate of 32%, 5–6 foals could have been expected from these mares. There were 21 breeding herds in the population at that time. The 2 herd stallions displaced each year affected about 10% of the mare population.

The effect of inbreeding in domestic livestock is generally detrimental, with fertility and viability of the offspring being two of the traits affected (Warwick & Legates, 1979). The MZNP population is derived from a small number of individuals; a single stallion from a different

population was added in the early 1970s. The reduction in heterozygosity per generation in 1965 (9 ♂♂; 25 ♀♀) was calculated as 1.8%; by 1973 (21 ♂♂; 60 ♀♀) it had dropped to 0.8%; and in 1984 (35 ♂♂; 78 ♀♀) it was 0.05% (Wright's formula quoted by Warwick & Legates, 1979). This is rather low and inbreeding is probably of minor importance at this stage.

Infertile or subfertile herd stallions would obviously influence the foaling rate. Semen evaluation has not been done on any of the MZNP stallions, but herd records have not shown any stallions to be infertile.

Sufficient precipitation during the period that daylength is increasing will result in green, sprouting vegetation. After the dry winter the mares will therefore be on a rising plane of nutrition. Lean domestic horse mares that are gaining weight at the beginning of the breeding season generally have the greatest reproductive efficiency (Schryver & Hintz, 1980) and the same probably applies to other equids. Poor or erratic rainfall during the months of peak mating activity (November–February) may result in low conception rates among plains zebras in the Kruger National Park (Smuts, 1976).

The reproductive success of the MZNP mares seems very low compared to that of the two other equid populations cited. Nevertheless, the MZNP population increased from 55 to 230 in 20 years, at which level it is being maintained by the capture and translocation of surplus animals. The relatively poor grazing and harsh climate of the MZNP could adversely influence the foaling rate. During dry periods, apart from nutritional stress, the additional effect of lactation probably prevents Cape mountain zebra mares from cycling or conceiving and may also lead to resorption or abortion of the fetus. Embryonic resorption tends to occur 25–30 days after ovulation in domestic horse mares on a poor nutritional plane (van Niekerk, 1965). There are also indications that ecological factors are the most important causes of mortality in the MZNP population (Penzhorn, 1984b). Cape mountain zebras have been shown to be selective climax grazers feeding at a fairly high level off the ground (Grobler, 1983). Various antelope species inhabit the MZNP (Penzhorn, 1982b) and if low level grazing antelopes are allowed to increase to the extent that mean grass height is kept below that of mean zebra feeding height, it would be detrimental to the zebra population. Management policy should therefore be aimed at reducing interspecific competition for grazing between the zebras and other herbivores which inhabit the MZNP.

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