LAMB PREDATION IN PATAGONIAN RANCHES

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ABSTRACT: Lamb predation in Patagonia, Argentina, is considered by ranchers as the cause of one of their greatest losses and limits sheep production. Patagonian red fox (Dusicyon culpaeus) is the main predator and the magnitude of the problem reflects its distribution and abundance. Since 1979, the Bariloche Experimental Station of the Instituto Nacional de Technologia Agropecuaria (INTA) has performed 8 studies, totaling 1,717 lamb necropsies, with the purpose of determining the relative importance of predation and other causes of lamb mortality. This paper analyzes the causes of lamb mortality, with special reference to red fox and carnivorous bird predation. Red fox predation pattern is also discussed, based on the analysis of 157 cases of red fox kills.

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Red fox (Dusicyon culpaeus) is the main lamb predator in Patagonia, Argentina (Boelke 1957, Godoy 1963, Howard 1969, Bellati 1985). This native nocturnal canid is distributed throughout much of the Patagonia region. Mean weights are 8 kg for males and 6.7 kg for females, but adult weights can reach 13 kg (Crespo and De Carlo 1963). Its diet is primarily sheep, lagomorphs, and rodents (Crespo and De Carlo 1963, von Thungen, pers. comm.), and its density has been estimated between 0.7 and 1.9 individuals per km^2 (Crespo and De Carlo 1963, Rabinovich et al. 1987).

In addition to the value of its pelt, red fox is pursued energetically by local sheepmen with Victor-type traps, dogs, and toxic baits (strychnine and organo-phosphates) because of the damage it causes to sheep and goat herds. This has caused many serious quarrels between sheep raisers and wildlife conservation associations.

In Patagonia, 13 million sheep graze (Censo Nacional Agropecuario 1988). Sheep raisers often blame red fox for a great part of lamb losses, maintaining that sometimes this damage reaches 60% of lambs born. They give little or no importance to other mortality causes. Some technical information supports sheepmen's complaints. Rambeaud et al. (1975) reported that in Neuquen province, red fox was responsible for 60% of newborn lamb losses. Howard (1969) estimated that in favorable Patagonian habitats, red fox damage is between 5 and 15% of lambs born and recommended its control. Boelke (1957) found that in some places red fox abundance made sheep management very difficult and in some cases made sheep raising uneconomical. Godoy (1963) stated that the red fox is the most pursued and despised predator because of its attacks on sheep herds and its boldness of attack on rams. For these reasons the red fox is pursued, bounties paid for its pelts, and it is included in the National Cattle and Sheep Predators Law. Bellati (1986) estimated that in Pilcaniyeu Department, Rio Negro Province, 31% of lambs born were lost before marking and that red fox was responsible for 7.3% of these lamb losses.

There are other sheep predators in Patagonia, but because of their limited distribution and numbers their impact is not as high. Puma or mountain lion (Felis concolor) is an important sheep and cattle predator, but its distribution is limited to specific locations such as Andean foothills, northeastern Rio Negro Province, and southwestern Santa Cruz Province. For the mountain lion, no abundance estimates are available, but Patagonian sheepmen have reported them in high densities in the past. At present the lion is in very low numbers in our study areas and in nearly all the Patagonian region except the areas previously mentioned, where it is reportedly to be in high densities based on the many ranchers' complaints of high sheep and calf losses.

Dogs (Canis familiaris) prey mainly on adult sheep and their damage is especially significant in the areas surrounding the larger cities. Their predation pattern is recognizable and well known by sheep ranchers.

The pampas grey fox (Dusicyon gymnocercus) is another sheep predator; in Patagonia it is only found in northeastern Rio Negro Province and is not in our study areas. Control campaigns were carried out in La Pampa and Buenos Aires central provinces in the fifties against this grey fox in which 170,000 foxes were eliminated (Comision Mixta de Lucha 1955, in Crespo and De Carlo 1963). In another control campaign in the same provinces during the sixties, 145,000 grey foxes were removed (Godoy 1963).

Huron menor (Galictis cuja), gato pajero (Felis colocolo), gato montes (Felis geoffroyi), Patagonian grey fox (Dusicyon griseus), and the introduced mammals, mink (Mustela vison) and wild boar (Sus scrofa), have been reported as occasional sheep predators.

Carnivorous birds, i.e., Andean condor (Vultur gryphus), black vulture (Coragyps atratus), turkey vulture (Cathartes aura), black-chested eagle (Geranoaetus melanoleucus), crested caracara (Polyborus plancus), chimango caracara (Polyborus chimango), and gulls (Larus spp.) are considered by some sheepmen to be lamb predators, especially in the lambing and early post-lambing periods. Most of these birds are usually shot by ranchers, especially the condor, carancho, and vultures. The Andean condor was officially declared a vertebrate pest in some provinces (Bucher 1979).

In 1979 INTA Bariloche Experimental Station began a series of studies to identify and assess the relative importance of lamb mortality causes in Patagonia. Since then 8 studies have been made in 3 different locations. The results of these studies are presented in this paper, with special reference to red fox and carnivorous bird predation as a cause of lamb mortality. As no red fox predation pattern description was found in the literature, an analysis in this respect is also presented.

STUDY AREA

The Argentine Patagonia occupies an area of 800,000 km^2. Except for a narrow strip close to de Cordillera de los Andes, this is a semidesert area with an annual rainfall averaging 150 to 350 mm, part of which is snow. Frosts are frequent and can occur year-round. Strong winds are usual year-round too

(Bustos, pers. comm.). The landscape is hilly with plateaus and the soil is a sandy-clay, with pebbles in the soil profile and little organic matter (Marcolin, pers. comm.). Vegetation is composed of bunch grasses belonging mainly to genera Stipa, Poa, and Festuca and shrubs of genera Mulinum, Nassauvia, Verbena, and Senecio. The average vegetation soil-cover ranges from 30 to 60%.

The most important Patagonian agricultural production is Australian Merino and Corriedale sheep and their crossbreeds. Sheep are raised for wool in natural pastures with no supplemental feeding. Because the sheep meat industry is small, only a few lambs are sent to market. Adult sheep and lambs graze year-round in Patagonian winter and summer pastures. Carrying capacity varies, from 1 sheep every 1 to 10 hectares. Lambing season occurs in spring (October to November) in northern Patagonia and a month later in southern Patagonia. Lambing rates are not known because production records are first taken at marking time when lambs are castrated, marked, and docked. Marking rates are very variable depending on breed and type of management and range from 32 to 86% (Wardrop 1971, Rambeaud et al. 1975, Fiorio 1975, Obregon 1975, Morris 1977, Censo Nacional Agropecuario 1977, Quintas y Layana 1982, Irazoqui 1984, INTA, Centro Regional Patagonia Norte 1987), but all these authors agree that mean marking rates are low and near 50%. Because of this type of record keeping, the magnitude of lamb mortality before marking is not known, but it is suspected to be the highest (Simmons 1973).

METHODS

Eight studies on lamb mortality have been performed by INTA Bariloche Experimental Station agents in which 1,717 lamb carcasses were examined. Authors, lambing year, location of each study, and number of carcasses examined are shown in Table 1.

Table 1. INTA Bariloche Experimental Station lamb mortality studies in Patagonia ranches.

Lambing year	Authors	Location	Number of necropsies
1979	Olaechea et al. (1981)	Pilcaniyeu R.N.	406
1980	Olaechea et al. (1983)	Pilcaniyeu R.N.	167
1981	Olaechea et al. (1984)	Pilcaniyeu R.N.	249
1981	Bellati et al. (1982)	Rio Grande T.d.F.	217
1984	Robles (1984)	Rio Grande T.d.F.	80
1984	Olaechea (1984)	Apelegh Ch.	104
1985	Bellati & von Thungen (1988)	Pilcaniyeu R.N.	452
1986	Bellati & von Thungen (1987)	Pilcaniyeu R.N.	42

In the first six studies only perinatal lamb mortality was taken into account. This period of a lamb's life goes from parturition to the first 7 days of age, and the mortality occurring during this period is considered to be the highest (Simmons 1973). The causes of mortality affecting this period have qualitative and quantitative differences with those affecting other lamb life periods. Because of this, at first, perinatal mortality was studied alone. As time passed, it became evident and necessary that predation and other causes of mortality in older lambs needed to be evaluated, and the 1985 Rio Negro study included carcasses of lambs from 7 to 60 days of age. In the last study, only lambs of this age were taken into account.

The McFarlane (1965) lamb necropsy method was used for describing perinatal lamb carcasses. This method is based on the analysis of stomach content, fat reserve depletion, the presence of dystocia edema, and the presence of evidence of breathing and walking. It also gives criteria for estimating the lamb's time of death. Criteria for differentiating carcasses of lambs older than 7 days from carcasses of younger lambs were: weight of more than 5 kg; big size in heavily preyed-upon carcasses; important retraction of umbilical arteries; presence of green matter in stomach; big development of feet, with important waste of the volar face and volar membranes completely disappeared.

In all studies, carcasses were collected from private sheep ranches. Ranch horsemen collected daily all lamb carcasses from lambing pastures. These carcasses were taken, properly identified, to the labs where necropsies were conducted. For each lamb a datum card was made up which included: date, name of the pasture and the ranch where the carcass came from, name of the professional in charge of the necropsy, external and internal description of the carcass, mortality cause, description of the predation, if any, and time of death. For perinatal lamb mortality studies, carcasses were collected until lambing finished. For 7- to 60- day-old lamb mortality studies, collection began a week after the lambing peak occurred and finished at marking time.

Criteria for evaluating evidence of predation and the patterns of wounds caused by canid predators, mountain lions, and carnivorous birds were taken at first from Rowley (1970), Davenport et al. (1973), Roy and Dorrance (1976), and later from O'Gara (1982) and Wade and Bowns (1984). In each predation case a differential diagnosis was performed. For more accuracy in the diagnosis of wounds, sheep ranchers were consulted about mountain lion and domestic dog predation and they agreed with the patterns described in the literature. Two cases of heavy dog predation occurring outside the study area were used as additional evidence to confirm dog predation patterns. Furthermore, during the study, horsemen of ranches included in the studies were asked to report any mountain lion or dog attacks.

Since no description of Patagonian red fox predation patterns was found in the literature, we began to work with the description provided by local sheepmen: no more than one lamb killed per night, and wounds in the throat. We added to this description: no open wounds, no multiple bites, and no torn tissue. Bites in the head were recorded as red fox predation only if they were not open wounds.

To describe the predation pattern 157 cases of red fox kills were analyzed. This analysis included: 1) location of wounds caused by bites, 2) presence or absence of external attack evidence, 3) whether feeding occurred after the attack, 4) place of entry for feeding (recorded only in 41 cases), 5) parts of the carcass fed upon (recorded only in 61 cases).

Although the main criteria for describing carnivorous bird predation were found in the literature, field work was conducted in this respect. A hundred observation hours were spent in a pasture located in the study area, where 2,500 ewes were lambing. Three high observation points were established in the pasture whose owner blamed birds for lamb losses and shot them. Data recorded included: 1) interactions between carnivorous birds and lambing ewes, 2) interactions between birds and lambs dead or alive, 3) carnivorous bird species present in the pasture, and 4) flock size at one moment.

In the first 6 studies all lambs were necropsied except the carcasses that were heavily preyed upon or badly decayed. In the last two studies lambs heavily preyed upon were included. Investigators looked for bite holes in the neck or back skin, subcutaneous hemorrhages, and broken bones.

In the general analysis, predation rates resulted from the sum of dog, red fox, and bird primary, secondary, and nondetermined predation. Primary predation was determined if the carcass showed only fatal wounds caused by predators. Secondary predation was recorded when, besides the wounds produced by predators, the carcass showed signs of a weakened lamb such as depleted fat reserves, empty stomach, or evidence of disease. In some cases predation couldn't be identified as primary or secondary because organs usually observed for verifying whether there were some predisposing conditions to predation had been eaten or mutilated by the killing predator or by scavengers. These cases were recorded as "nondetermined predation." Also postmortem predation was recorded. Criteria for determining primary, secondary, and postmortem predation were taken from Rowley (1970).

For making mortality causes analysis simpler, exposure-starvation were put together, and accidents, abortions, failure to breathe, disease, and congenital abnormalities were recorded as "other causes." Dystocia and predation were analyzed separately. Because of decaying or heavy predation, in some cases mortality cause was impossible to determine; these cases were recorded as "without diagnosis."

RESULTS

General Mortality Results

Relative importance of perinatal lamb mortality causes is shown in Table 2, and for lambs of 7 to 60 days of age in Table 3. Results are presented as percentages of cases over total number of carcasses analyzed in each study. Predation analysis results are shown in Table 4 for perinatal lambs and in Table 5 for older lambs.

Cases of dog predation were recorded in a 1984 Tierra del Fuego perinatal mortality study and in a 1985 Rio Negro 7- to 60- day-old mortality study. Red fox postmortem predation rates were very low; only one case appeared in the 1981 and 1985 perinatal and in 1986 7- to 60-day-old Rio Negro studies. No carnivorous bird primary predation case was determined. Most bird predation was postmortem and secondary. No mountain lion predation was determined in these studies.

Red Fox Predation Pattern

Most lamb carcasses preyed upon by red fox (52.8%) had wounds in the neck and in the back simultaneously. Carcasses showing only wounds in the back were 25.4%; only in the neck, 16.5%; and only in the head, 5%. Neck wounds, located more precisely in the throat region, were so deep that subcutaneous tissue and organs such as larynx, trachea, and thymus gland were affected; sometimes jaw and cervical vertebrae appeared broken, accompanied by clots and wounds in the spinal cord. In many cases more than one bite appeared in the throat, but it wasn't recorded on data cards. Back wounds were very deep, damaging the intercostal, back, and shoulder muscles, heart and lungs, and, in many cases, ribs appeared broken. Twenty-one carcasses (13.4%) showed no external evidence of attack.

Table 2. Relative importance of perinatal lamb mortality causes in 7 studies in Patagonia ranches.

L.Y.	Loc.	n	E-S	D	P	O	W.D.	%
1979	R.N.	406	75.6	9.1	4.7	5.4	5.2	100
1980	R.N.	167	75.4	7.1	9.6	0.6	5.9	98.5
1981	R.N.	249	50.9	8.8	19.2	3.2	17.6	99.7
1981	T.d.F.	217	55.2	17.9	16.5	0.5	9.6	99.7
1984	T.d.F.	80	66.2	18.7	11.2	-	3.7	99.8
1984	Ch.	104	79.8	2.8	11.5	0.9	4.8	99.8
1985	R.N.	406	48.3	17.4	21.6	1.9	10.8	100

L.Y. = lambing year, Loc. = location, n = number of necropsies, E-S = exposure-starvation, D = dystocia, P= predation, O = other causes, W.D. = without diagnosis.

Table 3. Relative importance of 7- to 60-day old lamb mortality causes in 2 studies in Rio Negro Province ranches.

Lambing	n	Exposure-Starvation	Predation	Other causes	Without diagnosis	%
1985	46	15.2	45.6	15.2	23.9	99.9
1986	42	26.2	42.8	14.3	16.6	99.9

Table 4. Red fox and carnivorous bird predation rates in 7 perinatal lambs mortality studies in Patagonia ranches.

		Red fox predation			Bird sec.	Total
Lambing	Loc.	Prim.	Sec.	No det.	predation	predation
1979	R.N.	1	0.2	0.5	2.9	4.7
1980	R.N.	1.8	3.6	-	4.2	9.6
1981	R.N.	4.8	6.4	3.2	3.6	19.2
1981	T.d.F.	3.2	3.6	-	9.6	16.5
1984	T.d.F.	-	1.2	-	7.5	8.7
1984	Ch.	4.8	1.9	1.9	2.9	11.5
1985	R.N.	6.4	3.9	3.2	8.1	21.6

Table 5. Red fox and carnivorous bird predation rates in two 7-to-60-day-old lamb mortality studies in Rio Negro ranches.

Lambing year	Red fox predation Prim.	Sec.	No det.	Bird sec. predation	Total predation
1985	28.6	6.5	8.7	-	43.4
1986	30.9	2.4	7.1	2.4	42.8

Red foxes fed on 81 carcasses (51.6%) and seemed to be prone to feed on abdominal and thoraxic viscerae (88.5%) and, in some cases, on limb muscle. Five lambs (8%) appeared eaten in parts of the head (muscle, bone, and grey matter) and in 2 cases (3%) carcass consumption was almost complete. The place most used as feeding entry was the one located under and behind the thorax (71%). Clots and serious subcutaneous hemorrhage in the edges of feeding entries were taken as evidence of the lambs being fed upon when still alive. This appeared frequently but it wasn't recorded on data cards.

Carnivorous Bird Predation Pattern

More common wounds inflicted by Patagonian carnivorous birds were removal of the tongue and both eyeballs, and these are the first tissues to be fed upon. The birds can devour the carcass almost completely, entering mainly by two points: mouth and anus and sometimes through the very thin axillar skin of younger lambs. A flock composed of twenty birds, representing both caranchos and black vultures, can eat a 30-day-old lamb in less than 2 hours (Sarasqueta, pers. comm.).

Carnivorous Bird Behavior

In the hundred observation hours, no interaction between birds and live lambs was recorded. Two interactions with lambing ewes having stillborn lambs were observed; one ewe successfully defended its dead lamb during 35 minutes from two chimangos that finally began to feed when the ewe deserted its lamb. A pregnant ewe carcass which had probably died during parturition was found being fed upon by chimangos, caranchos, and black vultures. It was nearly all consumed, but its fetal membranes remained intact.

Of the carnivorous bird species blamed as lamb predators, only the Andean condor, chimango, carancho, black-chested eagle, and black vulture were seen in the pasture during the observation period. Many flocks of chimangos and caranchos were seen and their flock size ranged from 1 to 6 and 1 to 7 individuals, respectively. Only one vulture flock was seen at one time, and this size varied between 7 and 81 individuals. The same occurred with the condor, and its size was of 2 individuals. Three pairs of adult eagles were nesting in the pasture and 2 yearlings were seen there too. An abundant gull population was seen in an adjacent pasture, but didn't enter the study pasture.

DISCUSSION

In perinatal lambs it's clear that exposure-starvation was the most important mortality cause; in all studies exposure-starvation rates were the highest, ranging between 48 and 80%. Dystocia was a second important mortality cause, especially in Tierra del Fuego ranches, where the only sheep breed is Corriedale, which has more dystocia problems because it gives birth to heavier lambs. Bird and red fox predation was second as the most important cause of mortality for this lamb category. Sheep producers must give greater attention to causes of mortality other than predation in perinatal lambs. In this perinatal category the highest primary predation rate was 6.4% in the 1985 Rio Negro study, and in secondary predation cases most of the weakening factors were so severe in the lambs that red foxes only act as accelerators of death that would have happened with or without predators present.

In the 7- to 60-day age category, predation was the main mortality cause (45.6 and 42.8%). Exposure-starvation and other causes, especially pulpy kidney clostridial infections, were the second most important mortality causes.

Birds happen to be only secondary and postmortem predators, according to Rowley (1970). This author pointed out that trouble between birds and lambs is most likely to occur at two stages in the lamb's life: the first is during or soon after parturition; the second is when a lamb has been temporarily or permanently abandoned by its mother. Weakening factors in Patagonia were principally exposure-starvation and secondarily dystocia. These factors are easily detected in a carcass, but in the specific case of a lamb attacked by birds in the first stage cited by Rowley (1970), the method was useless to differentiate primary predation on a healthy lamb from secondary predation on a lamb weakened by exposure that couldn't stand up and walk. Because of this, many sheep producers consulted held that bird damage occurred during parturition. Since Smith (1965) pointed out that in most cases lambs were attacked during the immediate postparturient period before lambs suckled, we decided to conduct field observations of bird/lamb interactions. In these observations no bird attack on a healthy lamb was recorded, according to the results of necropsies. As a conclusion, our results show that patagonian carnivorous birds have no impact on healthy lambs, but more research is needed in this respect.

In the 7-to-60-day-old lamb category, predation was the main cause of mortality (45.6 and 42.8%). All predation cases except two (one by a dog and the other by birds) were red fox kills (43.4%). Most were primary predation. But because Henne (1975) found the same rate in weakened and healthy lambs in coyote kills, the importance of weakened condition causing predation of lambs of this age is in doubt.

The red fox predation pattern shows some similarities to that recorded for coyote kills by Davenport et al. (1973), Henne (1975), and Wade and Bowns (1984), and to the one recorded for red fox (Vulpes vulpes) by Rowley (1970). Although both canid predators inflicted wounds in lambs' throats and in lambs' backs, in most cases they preferred to bite in the throat only, not in both places as the Patagonian red fox does. The same authors stated that many bites can occur in the same location and that both predators preferred to feed upon thoraxic and abdominal viscerae and fat, as in the Patagonian fox pattern.

The coyote and Patagonian fox normally begin feeding in a similar location: behind and under the thorax. Apparently this is a quick and easy mode of feeding entry. Davenport et al. (1973), Connolly et al. (1976), Roy and Dorrance (1976), Henne (1975), and Wade and Bowns (1982) report coyote feeding entries as this paper does for red fox. Coyote kills not fed upon were reported to be common by Henne (1975),

Nass (1977), and Andelt et al. (1980). In this paper red fox didn't feed in 48% of their kills. Andelt et al. (1980) stated that surplus killing by coyotes may be related to the abundance of domestic prey that has lost many of its avoidance strategies. This also can occur with the red fox in a year when there is lamb abundance.

Rowley's (1970) recommendation of completely skinning the carcass to look for wounds caused by predators may, at first, seem extreme. However, when completely skinned, characteristic red fox wounds were found in 21 carcasses with no external evidence of attack. In these cases length and seriousness of the subsequent wounds were severe: necropsies revealed broken ribs and broken vertebrae and deep wounds with great hemorrhages in organs such as trachea, larynx, lung, and heart, but no stains, teeth punctures, or any other external evidence of predation.

No mountain lion predation was found in these studies, but for Santa Cruz Province, Quintas and Layana (1982) reported heavy mountain lion predation on sheep and lambs.

CONCLUSIONS

Lamb losses by causes other than predation are very high and must be considered simultaneously with red fox control if ranchers want to diminish their lamb losses, especially in the perinatal period.

Carnivorous birds are not a problem for sheep raising in Argentina and must be protected from shooting and poisoning.

More research is needed on mortality causes of lambs older than 60 days.

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