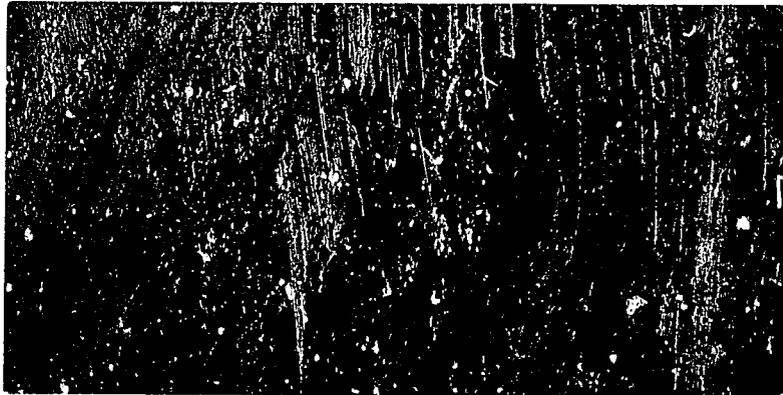


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**ESTRUS AND OVULATION IN CRIOLLO,  
CORRIEDALE AND JUNIN SHEEP IN THE  
CENTRAL SIERRA OF PERU**

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ESTRUS AND OVULATION IN CRIOLLO, CORRIEDALE AND  
JUNIN SHEEP IN THE CENTRAL SIERRA OF PERU.

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SUMMARY

This study was conducted during three years (April 1981 - April 1984) in the Central Sierra of Peru (12° South latitude, 76° West longitude and approximately 3,800 m elevation). A total of 135 ewes of three breeds (Criollo, Corriedale and Junin) and three ages (1.5, 2.5 and 3.5 years) grazed on native pasture were examined monthly by laparoscopy to determine the incidence and rate of ovulation. The occurrence of estrus was measured daily using painted teaser rams. The incidence of estrus was 22.0 vs. 28.9 and 30.7% ( $P < 0.01$ ) for Criollo, Corriedale and Junin ewes and 26.4, 28.5 and 27.0% ( $P > 0.05$ ) for 1.5, 2.5 and 3.5 years of age. The incidence of ovulation differed significantly among breeds (Criollo, 54; Corriedale, 33; and Junin, 34%;  $P < 0.01$ ) and ages (36, 41 and 43%;  $P < 0.05$ ) for 1.5, 2.5 and 3.5 years, respectively. The incidence of ovulation was higher ( $P < 0.01$ ) during February - July (fall and winter, range 43 - 82%) with the Criollo breed tending to be less variable. The

mean ovulation rate was 1.15, 1.14 and 1.13 for the Criollo, Corriedale and Junin, respectively, and 1.15, 1.15 and 1.14, for ewes 1.5, 2.5 and 3.5 years of age, respectively ( $P > 0.05$ ). Overall incidence of ovulation was greater than that of estrus. It is possible under field conditions that all estrous periods were not observed. These data demonstrate that reproductive performance is limited by both the incidence of estrus and ovulation and of ovulation rate.

#### ESTRO Y OVULACION EN OVEJAS CRIOLLA, CORRIEDALE Y JUNIN EN LA SIERRA CENTRAL DEL PERU.

#### RESUMEN

Este estudio fue conducido durante tres años (Abril 1981-Abril 1984) en La Sierra Central del Perú ( $12^\circ$  Latitud sur,  $76^\circ$  longitud oeste y aproximadamente 3,800 m de elevación). Un total de 135 ovejas de tres razas (Criolla, Corriedale y Junín) y tres edades (1.5, 2.5 y 3.5 años) mantenidas en pradera nativa, fueron examinadas mensualmente por laparotomía para determinar la incidencia y tasa de ovulaciones. La ocurrencia de estros fue medida diariamente utilizando carneros marcadores vasectomizados. La incidencia de estro fue de 22.0 vs 28.9 y 30.7% ( $P < 0.01$ ) para ovejas Criolla, Corriedale y Junín y 26.4, 28.5 y 27.0% ( $P > 0.05$ ) para ovejas de 1.5, 2.5 y 3.5 años de edad. La incidencia de ovulaciones fue significativamente diferente entre razas (Criolla, 54; Corriedale, 33; y Junín, 34%;  $P < 0.01$ ) y edades: 36, 41 y 43%; ( $P < 0.05$ ) para ovejas de 1.5, 2.5 y 3.5 años,

respectivamente. La incidencia de ovulaciones fue mayor ( $P < 0.01$ ) durante Febrero - Julio (Otoño e invierno, rango 43-82%), donde la raza Criolla mostró menor variación. La tasa de ovulación media fue de 1.15, 1.14 y 1.13 para Criolla, Corriedale y Junín, respectivamente, y 1.15; 1.15 y 1.14 para ovejas de 1.5, 2.5 y 3.5 años de edad, respectivamente ( $P > 0.05$ ). La incidencia de ovulaciones fue mayor que la incidencia de estros. Bajo las condiciones de campo, es probable que no todos los períodos estruales hayan sido observados. Esta información demuestra que el desempeño reproductivo está limitado por la incidencia de estro y ovulación y la tasa de ovulación.

#### Introduction

The reproductive activity in sheep is affected by the length of daylight (Yeates, 1949). The magnitude of the photoperiod varies with the geographic latitude. The seasonal reproductive response of sheep to this variation is more pronounced when they are located far from the equatorial line (Hafez, 1952). However, the length of the estrous season also varies with genotype. Some breeds have long and some have a short breeding season which according to Lavasseur and Thibault (1980) is a dominant genetic characteristic. Sheep in tropical climates exhibit continuous sexual activity.

The Central Sierra is located at 11° south latitude, where the photoperiod variations are minimal, as it is in the Bolivian Altiplano. Due to this proximity to the equatorial line, the

estrous season of sheep should be prolonged. The sexual activity of sheep in this region is not well documented. Cardozo and Foote (1969) showed that the Corriedale and Criollo sheep in the Bolivian Altiplano have a higher incidence and rate of ovulation during June than in September-December. The incidence of ovulation in Criollo was higher than in Corriedale.

This study attempted to determine the incidence of estrus and the incidence and rate of ovulation throughout the year in Corriedale, Criollo and Junin sheep under the native range conditions of the High Central Sierra of Peru.

#### Materials and Methods

This study was conducted during three years (April 1981 - March 1984) in the Central highland of Peru at 12° South latitude, 75° West longitude and at approximately 3,800 m elevation. The experimental design including the number of animals used by breed and age are shown in Table 1.

Beginning in the second year, a new set of 15 animals per breed of 1.5 years old were added to the experiment and those animals 4.5 years old were discarded. The initial 1.5 and 2.5 year old animals were shifted to the next older age group (2.5 and 3.5).

All ewes were managed similarly and grazed on native pasture. The incidence of estrus (ewes in estrus/ewes exposed to teaser male) was obtained daily using painted teaser rams placed

continuously with the ewes. It is possible under field conditions that all estrous periods were not observed. The teaser rams used for estrus detection were changed every 28 days, and the color of marking paint every 14 days. The monthly incidence of ovulation (ewes ovulating/ewes observed) and rate (no. of CL/ewes ovulating) were obtained by the presence of corpora lutea through direct inspection of ovaries using the laparoscopy technique. One third of each subgroup were examined each month with all ewes being examined once every three months.

The experimental data were organized and statistically analyzed by breed, age and month for incidence of estrus, ovulation and ovulation rate.

## Results

### Incidence of Estrus.

The overall proportion of ewes showing estrus by breed and age is shown in Table 2. The Criollo breed showed a statistically ( $P < 0.01$ ) lower incidence of estrus (22.0%) compared to the Junin and Corriedale breeds (30.7 and 28.7%, respectively). No statistical ( $P > 0.05$ ) differences were found among ages, or the interaction between breed x age, indicating that the breed influence is independent of age (Table 3).

The mean monthly incidence of ewes showing estrus by breed, and age is shown in Tables 4 and 5, respectively. The interaction breed x month was statistically significant ( $P < 0.01$ ), indicating that the behavior of breeds differed among months.

The performance of each breed by month is also depicted in Figure 1, showing that the higher occurrence of estrus was during the period of March to July decreasing from August to December and increasing again by January to March with a peak in May and June for Corriedale and Criollo and June for Junin. The depression in April is probably due to the stress of shearing. The Criollo sheep had lower mean monthly incidence of estrus, however, it was more extended than Corriedale and Junin sheep. The frequency distribution of estrus in regard to age of the animals seems to be similar. However, the peak of estrus when considered for all breeds was observed in May for ewes 1.5 and 2.5 years old and in June for ewes 3.5 years old.

The monthly mean of 1.26 estrous periods per Criollo ewe showing estrus was lower than 1.32 and 1.34 estrous periods of Corriedale and Junin ewes, respectively (Table 6). On the average, ewes 1.5 years old showed less monthly estrous periods than ewes of 2.5 and 3.5 years old. May (1.41) and June (1.47) were the months when the greatest number of estrous periods per month occurred per ewe (Tables 7 and 8). Individual breeds performed differently in terms of number of estrous periods per month, such as Criollo in May, Corriedale in June and Junin in July.

#### Incidence and Rate of Ovulations.

The proportion of ewes ovulating by breed, age and month is shown in Tables 9 and 10 and in Figure 1. The overall mean

incidence of ovulation was 40 percent. The Criollo breed showed 54% which was statistically ( $P < 0.01$ ) higher than the Corriedale (33%) and Junin (34%) sheep. The overall mean incidence of ovulation of ewes 2.5 years old (41%) did not differ statistically ( $P > 0.05$ ) from the 1.5 and 3.5 year olds. However, ewes 1.5 years old did have a significantly ( $P < 0.05$ ) lower incidence of ovulation (36%) than ewes 3.5 years old (43%).

The interaction of breed x age was statistically significant ( $P < 0.05$ ), indicating a differential response of breed at different ages. The incidence of ovulation was similar ( $P > 0.05$ ) among ages for the Junin and Criollo breeds, whereas a significant difference ( $P < 0.05$ ) occurred among ages in the Corriedale. The Criollo sheep consistently had a higher incidence of ovulation in all age groups ( $P < 0.05$ ) than the Corriedale and Junin which were similar ( $P > 0.05$ ).

Table 10 shows that the incidence of ovulation was greater from February to July ( $P < 0.05$ ) than during other periods of the year. The Criollo sheep showed higher monthly mean frequency of ovulation throughout the year than the Corriedale and Junin ( $P < 0.05$ ). The peak of the occurrence of ovulation for all breeds was found in March (90, 84 and 71 percent for Criollo, Junin and Corriedale, respectively).

The overall mean ovulation rate was 1.14. Mean ovulation rates by breed, age and month are shown in Tables 11 and 12. Ovulation rates are low with no significant differences ( $P > 0.05$ ) among breeds and ages. In general, March was the month which

showed a higher ovulation rate (1.30). The Criollo (1.30) and Junin (1.36) showed their highest ovulation rate in March and the Corriedale (1.38) in August.

#### Discussion

The results of this investigation show that the incidence of estrus in Junin, Corriedale and Criollo sheep at the Central Sierra of Peru is affected by photoperiod even though the latitude is only 18°.

The day length variation is not pronounced due to proximity to the equatorial lane. The seasonality of sheep reproduction is a reality in the highlands of Peru (Varela, 1958) and Bolivia (Cardozo and Foote, 1969), but it is extended from February to August (mid-summer, fall and mid-winter). The Criollo sheep show longer estrus activity (January to July) compared to Junin and Corriedale breeds (March to August). The Criollo sheep showed a lower incidence of estrus from August to December and the Corriedale and Junin from July to January. Age did not affect the incidence of estrus. There was a tendency for young ewes to enter anestrous earlier than the adults. This incidence of estrus tended to be lower in all breeds and ages during April and could be related to shearing stress. This coincides with previous reports on this matter (Kilgour and Langen, 1970; Doney et al., 1976).

The proportion of ewes ovulating in Corriedale and Junin breeds was similar with a clear tendency to show the greater incidence between March to June. This incidence decreased from July to January, increasing again in February to show the peak in March. The Criollo breed differed from the Corriedale and Junin in the proportion of ewes ovulating. In the Criollo breed, the highest incidence of ovulation was in March with a second peak in November. The highest proportion of ovulations in Criollo was observed during March to July. This level was not surpassed by Corriedale and Junin breeds. The Criollo appears to exhibit a less marked seasonality than the Corriedale and Junin. However, confirming the findings of Cardozo and Foote (1969) with Corriedale and Criollo sheep in the Bolivian Altiplano, a greater incidence of ovulations was observed in June than in the period from September to December. In general for all breeds (Corriedale, Junin and Criollo), the higher incidence of ovulation took place from March to June with an additional peak in November for Criollo sheep. This could be due to the stimulating effect of the nutritional level resulting from the initiation of the rainy season (Cumming, 1977; Cumming and Findlay, 1977). The Criollo sheep compared to Corriedale and Junin ewes have shown a greater incidence of ovulations throughout the year. The incidence of ovulation of ewes 1.5 years old was significantly lower compared to 2.5 and 3.5 year old ewes.

The mean ovulation rate throughout the year was low. No clear tendency of variation due to season, breed or age was

found. Many factors might be acting to reduce the ovulation rate, such as breed, level of nutrition, season and age (Gordon, 1958; Land, 1978; Gunn et al., 1979). Further research studies should be planned to more specifically determine and overcome the cause(s) of the low ovulation and fertility rate and high fertilization failure and/or embryo-fetal loss as reported by Cordozo and Foote (1969) for the Bolivian altiplano, Vivanco et al. (1985) for Central Sierra and Sumar et al. (1985) for the southern altiplano of Peru. No direct relationship was shown between the incidence of ovulation and ovulation rate. Reports for other breeds have shown increased ovulation rate during mid breeding season (Bindon and Piper, 1981). But, in this study, no significant variation was found. This may be due at least in part to the low ovulation rate.

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Table 1. Experimental design and number of ewes by breed and age.

Age (years)	Breed			Total
	Corriedale	Criollo	Junin	
1.5	15	15	15	45
2.5	15	15	15	45
3.5	15	15	15	45
Total	45	45	45	135

Table 2. Incidence (%) of ewes in estrus by breed and age (April 1981–April 1984). Central Sierra – Peru.

Breed	Age (years)			Total
	1.5	2.5	3.5	
Junin	28.1(555)*	33.4(518)	30.6(545)	30.7(1618)a
Corriedale	26.6(538)	30.6(546)	28.9(554)	28.7(1638) <sup>a</sup>
Criolla	24.4(549)	22.4(549)	20.2(549)	22.0(1647) <sup>b</sup>
Total	26.4(1642) <sup>a</sup>	28.5(1612) <sup>a</sup>	27.0(1648) <sup>a</sup>	27.3(4902)

\* Number of estrous periods recorded.

P < 0.01 for means with different superscript letters.

Table 3. Chi square values and probability levels for incidence of estrus by main effects and interactions in sheep. Endoscopy study (C. Sierra, Peru, 4. 981 - 4.1984).

Source of Variation	d.f.	X <sup>2</sup> Value	Probability Level
Breed (B)	2	6.77	P < 0.01
Age (A)	2	2.40	N.S.
Month (M)	11	914.44	P < 0.001
B x A	4	6.70	N.S.
B x M	22	83.11	P < 0.001
A x M	22	23.71	N.S.
B x A x M	43	17.94	N.S.
TOTAL	106	1055.07	P < 0.001

Table 4. Incidence (%) of ewes showing estrus by breed and month (April 1981 - April 1984). Central Sierra, Peru.

Month	BREED			Total
	Junin	Corriedale	Criolla	
April	36.9(174)*	33.9(171)	28.3(180)	33.0(524)
May	64.9(174)	68.2(135)	43.0(135)	58.7(404)
June	65.7(134)	60.7(135)	36.3(135)	54.2(404)
July	49.3(134)	55.2(134)	28.9(135)	46.9(403)
August	38.4(133)	32.8(134)	13.3(135)	28.1(402)
September	15.0(133)	14.2(134)	9.6(135)	12.9(402)
October	6.2(130)	7.5(133)	5.3(132)	6.6(395)
November	0.8(130)	0.0(133)	0.8(132)	0.5(395)
December	3.1(129)	2.3(133)	2.3(132)	2.5(394)
January	13.2(129)	9.0(133)	21.2(132)	14.5(394)
February	20.2(129)	14.4(132)	34.1(132)	22.9(393)
March	48.8(129)	43.5(131)	37.9(132)	43.4(392)

\* Number of ewes observed.

Table 5. Incidence (%) of ewes showing estrus by age and month (April 1981 April 1984). Central Sierra, Peru.

Month	Age (years)		
	1.5	2.5	3.5
April	31.5(178)*	39.1(169)	28.8(177)
May	57.0(135)	61.9(134)	57.0(135)
June	46.7(135)	57.5(134)	58.5(135)
July	41.0(134)	47.0(134)	52.6(135)
August	26.9(134)	26.9(134)	30.6(134)
September	9.7(134)	15.7(134)	13.4(134)
October	6.8(132)	3.9(130)	9.0(133)
November	0.8(132)	0.0(130)	0.8(133)
December	3.0(132)	3.1(129)	1.5(133)
January	16.7(132)	12.4(129)	14.3(133)
February	26.5(132)	23.4(128)	18.8(133)
March	47.0(132)	46.5(127)	36.8(133)

\* Number of ewes observed.

Table 6. Mean number of estrous periods per month per ewe showing estus by age and breed (April 1981 – April 1984). Central Sierra, Peru.

Breed	Age (years)			Total
	1.5	2.5	3.5	
Junin	1.34(156) <sup>1</sup>	1.31(173)	1.38(167)	1.34(496)
Corriedale	1.26(143)	1.37(167)	1.32(160)	1.32(470)
Criolla	1.22(134)	1.32(120)	1.23(108)	1.26(362)
Total	1.28(432)	1.33(460)	1.32(435)	1.31(1327)

<sup>1</sup> Number of animals showing estrus.

Table 7. Mean number of estrous periods per month per ewes showing estrus by breed and month (April 1981 - April 1984). Central Sierra, Peru.

Month	BREED			Total
	Junin	Corriedale	Criolla	
April	1.38(64) <sup>1</sup>	1.31(58)	1.22(51)	1.31(172)
May	1.41(87)	1.36(92)	1.47(58)	1.41(237)
June	1.40(88)	1.45(82)	1.39(49)	1.42(219)
July	1.45(66)	1.35(74)	1.26(39)	1.37(179)
August	1.37(51)	1.23(44)	1.00(18)	1.26(113)
September	1.05(20)	1.16(19)	1.15(13)	1.12(52)
October	1.00(9)	1.00(10)	1.00(7)	1.00(26)
November	1.00(1)	- (0)	1.00(1)	1.00(2)
December	1.00(4)	1.00(3)	1.33(3)	1.10(11)
January	1.12(17)	1.25(12)	1.14(28)	1.16(57)
February	1.12(26)	1.16(19)	1.09(45)	1.11(90)
March	1.33(63)	1.28(57)	1.30(50)	1.31(170)

<sup>1</sup> Number of ewes showing estrus.

Table 8. Mean number of estrous periods per month per ewe showing estrus by age and month (April 1981 - April 1984). Central Sierra, Peru.

Month	Age (years)		
	1.5	2.5	3.5
April	1.22(55) <sup>1</sup>	1.35(66)	1.37(51)
May	1.36(77)	1.41(83)	1.44(77)
June	1.37(63)	1.45(77)	1.42(79)
July	1.40(55)	1.37(63)	1.34(61)
August	1.22(36)	1.25(36)	1.29(41)
September	1.08(13)	1.14(21)	1.11(18)
October	1.00(9)	1.00(5)	1.00(12)
November	1.00(1)	- (0)	1.00(1)
December	1.25(4)	1.00(4)	1.00(2)
January	1.14(22)	1.19(16)	1.16(19)
February	1.14(35)	1.10(30)	1.08(25)
March	1.29(62)	1.34(59)	1.29(49)

<sup>1</sup> Number of ewes showing estrus.

Table 9. Incidence (%) of ewes ovulating per ewes observed by breed and age (April 1981 - April 1984). Central Sierra, Peru.

Breed	Age (years)			Total
	1.5	2.5	3.5	
Junin	31(284)1aA	35(254)aA	37(253)aA	34(791) <sup>a</sup>
Corriedale	26(269)aA	34(279)bA	40(264)bA	33(810) <sup>a</sup>
Criolla	53(252)aB	56(213)aB	54(209)aB	54(674) <sup>b</sup>
Total	36(805) <sup>a</sup>	41(744) <sup>ab</sup>	43(726) <sup>b</sup>	40(2275)

1 Number of ewes observed.

P < 0.01, and P < 0.05 for means with different superscript letters between breeds and ages, respectively.

P < 0.05 for means with different superscript low case letters between ages within breeds and uppercase letters between breeds within ages.

Table 10. Incidence (%) of ewes ovulating per ewes observed by breed and month (April 1981 - April 1984). Central Sierra, Peru.

Month	BREED			Total
	Junin	Corriedale	Criolla	
April	76(59) <sup>1</sup>	64(56)	66(53)	69(168)
May	82(62)	67(63)	79(53)	76(178)
June	68(59)	55(64)	87(55)	69(178)
July	29(58)	47(55)	68(44)	47(157)
August	19(63)	20(66)	37(49)	24(178)
September	3(63)	8(61)	25(52)	11(176)
October	11(62)	10(62)	21(52)	14(176)
November	14(63)	13(67)	49(55)	24(185)
December	12(91)	17(92)	21(72)	16(255)
January	14(80)	9(86)	54(71)	24(240)
February	30(80)	40(89)	62(69)	43(238)
March	84(51)	71(49)	90(49)	82(149)

<sup>1</sup> Number of ewes observed.

Table 11. Mean ovulation rate per ewe ovulating by breed and age (April 1981 - April 1984). Central Sierra, Peru.

Breed	Age (years)			Total
	1.5	2.5	3.5	
Junin	1.14(87) <sup>1</sup>	1.14(88)	1.12(93)	1.13(268)
Corriedale	1.11(70)	1.13(94)	1.18(105)	1.14(269)
Criolla	1.20(133)	1.17(119)	1.09(112)	1.15(364)
Total	1.15(292)	1.15(301)	1.14(310)	1.14(903)

<sup>1</sup> Number of ewes ovulating.

Table 12. Mean ovulation rate per ewe ovulating by breed and month  
(April 1981 - April 1984). Central Sierra, Peru.

Month	BREED			Total
	Junin	Corriedale	Criolla	
April	1.11(44)*	1.14(36)	1.20(35)	1.15(115)
May	1.06(51)	1.12(42)	1.12(42)	1.10(135)
June	1.13(40)	1.14(36)	1.23(48)	1.17(124)
July	1.12(17)	1.00(26)	1.10(30)	1.07(73)
August	1.00(12)	1.38(13)	1.17(18)	1.19(43)
September	1.00(2)	1.00(5)	1.00(13)	1.05(20)
October	1.00(7)	1.00(6)	1.00(11)	1.00(24)
November	1.22(9)	1.11(9)	1.19(27)	1.18(45)
December	1.18(11)	1.19(16)	1.13(15)	1.17(42)
January	1.00(11)	1.00(9)	1.03(38)	1.02(58)
February	1.08(24)	1.19(36)	1.14(43)	1.15(103)
March	1.36(42)	1.23(35)	1.30(44)	1.30(121)

\*Number of ewes ovulating.

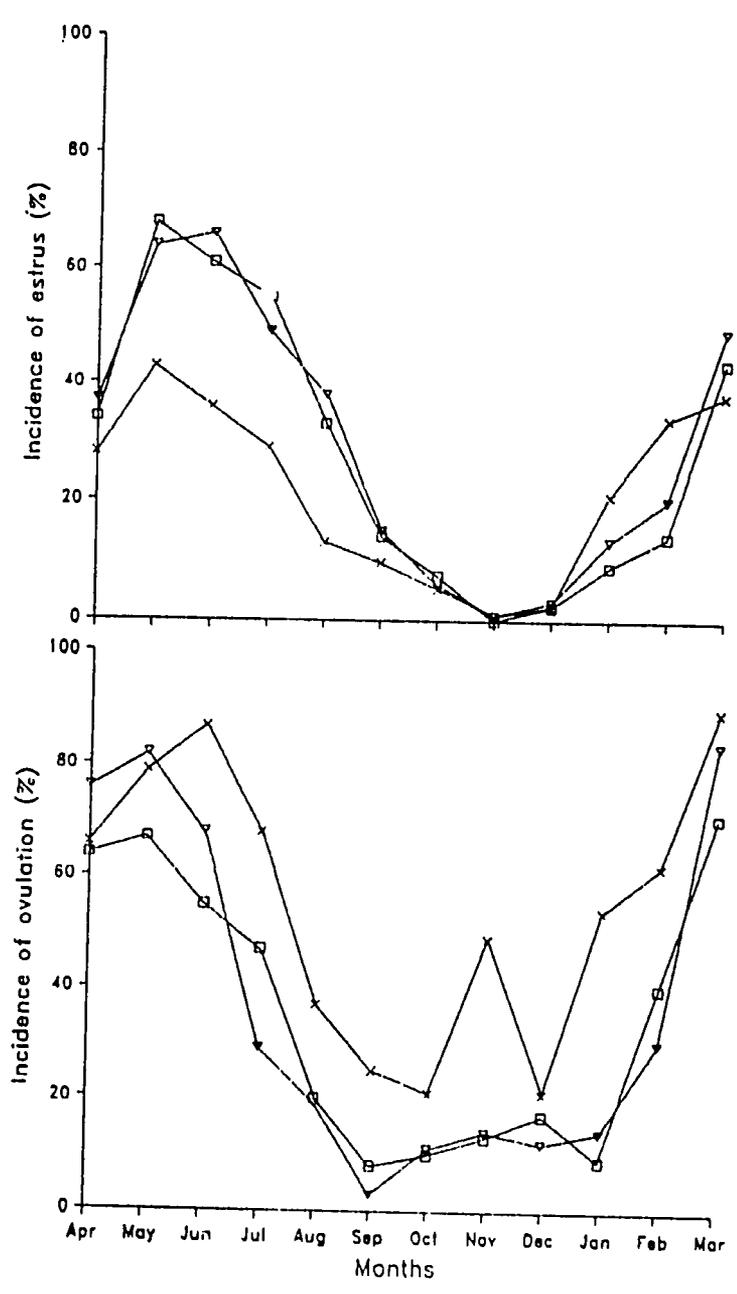


FIG 1. Monthly incidence of estrus and ovulation in Junin (▼), Corriedale (◻) and Criollo (✱) ewes.