FURTHER OBSERVATIONS OF BIGHORN SHEEP NON-TROPHY SEASONS IN ALBERTA AND THEIR MANAGEMENT IMPLICATIONS

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ABSTRACT

A total of 31 bighorn lambs (Ovis canadensis) has been selectively orphaned on Ram Mountain during the hunting seasons of 1972-76. Survival rates of lambs of both sexes and growth rates of female orphans are not different from their non-orphan counterparts. However, there appears to be a tendency toward stunting of orphan rams. Another aspect of the selective non-trophy season on Ram Mountain is the development and/or maintenance of a moderately high-quality population suggested by rapid initial horn growth in males, early maturation in females, high lamb production, average suckle durations and low lungworm loads. Management implications of a non-trophy season are discussed on the basis of data from "ewe" seasons in Alberta since 1966 and the population dynamics of the Ram Mountain herd.

INTRODUCTION

In response to a bighorn die-off in British Columbia, Alberta instituted a non-trophy season in 1966 to avoid a similar catastrophe and to try and maintain bighorn populations below or near carrying capacities of critical winter ranges. The first two non-trophy seasons allowed the harvesting of any bighorn with horns less than 12 inches in length. However, the 1968 regulations were modified to include ewes and lambs only, as it had become apparent that hunters were starting to select yearling rams. Non-trophy seasons have run from the end of August to the latter part of October, except for 1971 when the season began September 25. Approximately 340 permittees have harvested about 110 non-trophy sheep per year resulting in an annual harvest rate of less than 3 per cent of the total estimated harvestable population of 4,500 Alberta bighorns (excluding National Parks). Since 1966, approximately 1,300 non-trophy sheep have been harvested.

Obvious questions concerning the non-trophy season are: 1. what effect does orphaning have on the survival and subsequent growth of lambs and 2. how does this influence the population dynamics of a bighorn herd. The Ram Mountain orphan study was initiated in 1972 to examine these questions.

STUDY AREA

Ram Mountain comprises the southernmost extent of the Brazeau Range, lying south of the North Saskatchewan River Gap approximately 160 kilometers west of Red Deer, Alberta (Figure 1). Elevation varies from 1082m.

on the North Saskatchewan River to 2173 m. at the summit of Ram Mountain. Several intermittent drainage basins jut irregularly into the mountains, interrupting the continuity of the range. The terrain is varied, with bare rock summits, talus slopes, wooded slopes, low relief alpine tundra and rugged escarpments and cliffs (Hoffman, 1971). Ram Mountain was chosen for the trapping and marking study because of its isolation. The mountain is bordered on three sides by heavily forested foothills and on the fourth side by the North Saskatchewan River.

METHODS

To date, approximately 90 per cent of the herd has been marked. It appears that movements of bighorns across the river to the north comprises less than 5 per cent of the herd. Animals were captured in a corral-like structure baited with salt. Horn measurements and weights were recorded and fecal samples were taken. All trapped sheep were marked. Subsequent observations of suckles confirmed ewe-lamb combinations. Survival rates were determined by observations of marked animals in ensuing years. Approximately half of the marked lambs were selectivley orphaned by hunting each year between the end of August and the end of October. Fecal samples were analyzed for lungworm infection by the Baermann technique as described by Uhazy et. al., (1973). An unpaired t-test or a t-test of a single observation versus a sample taken during the same time period was used to compare weights and measurements of non-orphans to orphans.

RESULTS

Thirty-one lambs have been selectively orphaned between 1972 and 1976 (Table 1). Lamb survival, since the orphaning program began, is indicated in Table 2. There was no significant difference of survival to one year between orphans and non-orphans (Table 3). Live weights of female orphans did not differ from their non-orphan counterparts (Figure 2). Although not statistically significant, there was some indication that orphan rams weighed less than non-orphans (Figure 3). The suggested size discrepancy between orphan and non-orphan rams becomes more pronounced when examining horn lengths (Figure 4) and horn base circumferences (Figure 5). Mean non-orphan ram horn lengths and base circumferences were statistically larger ($p<0.05$) than orphans in approximately 28 per cent and 11 per cent of the cases respectively, where statistical comparisons could be made.

DISCUSSION

Orphan rams appear to exhibit below average growth, especially in horn development. The following hypothesis attempts to explain this phenomenon. At the time of orphaning, the lamb drops to the bottom of the dominance hierarchy In this situation the energy budget of the lamb may be "taxed" because of its premature subordinate status, thus resulting in retarded growth. Perhaps the variation in size isn't as acute in female orphans compared to female non-orphans since they are paedomorphic (i.e. the adult female retains juvenile characteristics of males including horn size and weight) and therefore do not exhibit such a large discrepancy in size between juvenile and adult form.

Fig. 1. Location of bighorn sheep herds referred to in the text including Ram Mountain.

Table 1. Number of marked ewes and lambs that were matched and number of ewes collected on Ram Mountain. (1972-1977)

Year	Ewes and Lambs Marked and Matched	Number of Matched Ewes Collected
1972	9	6
1973	12	5
1974	9	7
1975	13	8
1976	14	5
1977	11	6
Total	68	37

Table 2. Ram Mountain lamb survival 1972-1977.

Year	Lambs	Yearlings	2 Years	3 Years	4 Years	5 Years
1972	24[a](6)[b]					
1973	25(5)	14(4)				
1974	15(7)	18(3)	13(3)			
1975	20(8)	11(3)	14(2)	9(3)		
1976	21(5)[c]	12(7)	10(3)	14(2)	7(2)[d]	
1977	16(6)	17(4)	11(7)	9(3)	9(1)[e]	7(2)

[a] total number of lambs

[b] number of orphans included in total

[c] one lamb not included - status unknown - may have died before the ewe was collected.

[d] one non-orphan ewe collected in 1976.
one orphan ram found dead in trap (spring 1976)

[e] one orphan ewe collected in 1976.
one non-orphan ewe collected in 1976.

Table 3. Chi-square test for independence on survival to 1-year of non-orphan lambs versus orphaned lambs (1972-1977).

Status	Non-Orphan Lambs	Orphan Lambs	Total
Survived	51(51)	21(21)	72
Died	23(23)	10(10)	33
Total	74	31	105

( ) = expected values with the Chi-square Test for Independence.

(x^2 1df = 0.00, N.S. at p <0.005)

Table 4. Chi-square test for independence on 289 observations of bands sighted with 2-year-old orphan males vs. 2-year-old non-orphan males(1975-1977).

Band Type	Number of observations(Expected)		Total
	Non-orphan 2-Year-Old Males (n=10)	Orphan 2-Year-Old Males (n=3)	
Ewe-lamb-juvenile ram bands.	97(121)	81(57)	178
Ram only bands.	100(76)	11(35)	111
Total of all bands.	197	92	289

x^2 1df = 38.90 It is significant at P<0.005. The hypothesis that the number of observations of 2-year-old non-orphan males with female-lamb-juvenile ram bands is equal to the number of observations of 2-year-old orphan males with the same is rejected.

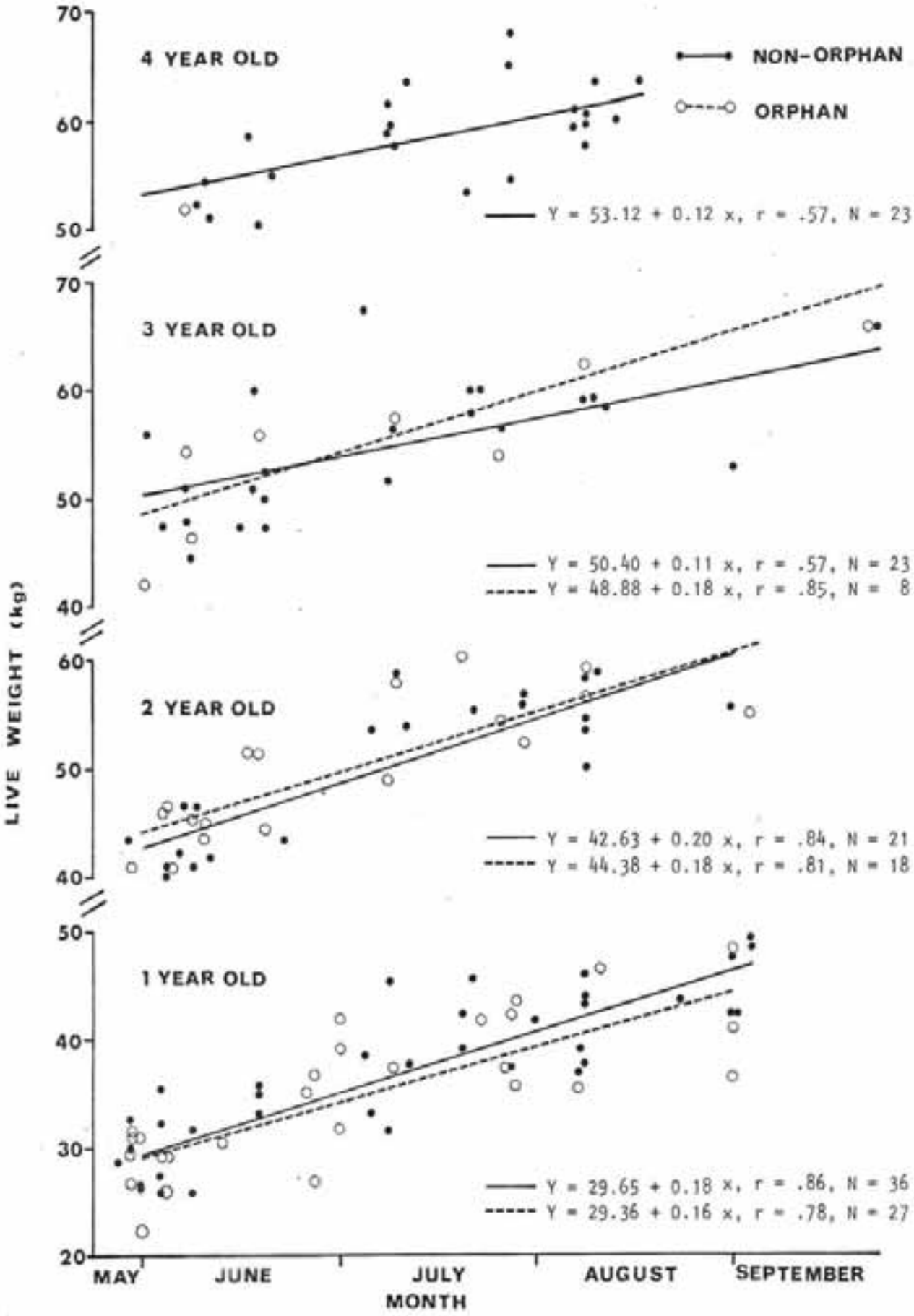

Fig. 2 Live weights of non-orphan vs orphan bighorn ewes from Ram Mountain 1975-1977. (June 1 = x_1 for regression lines)

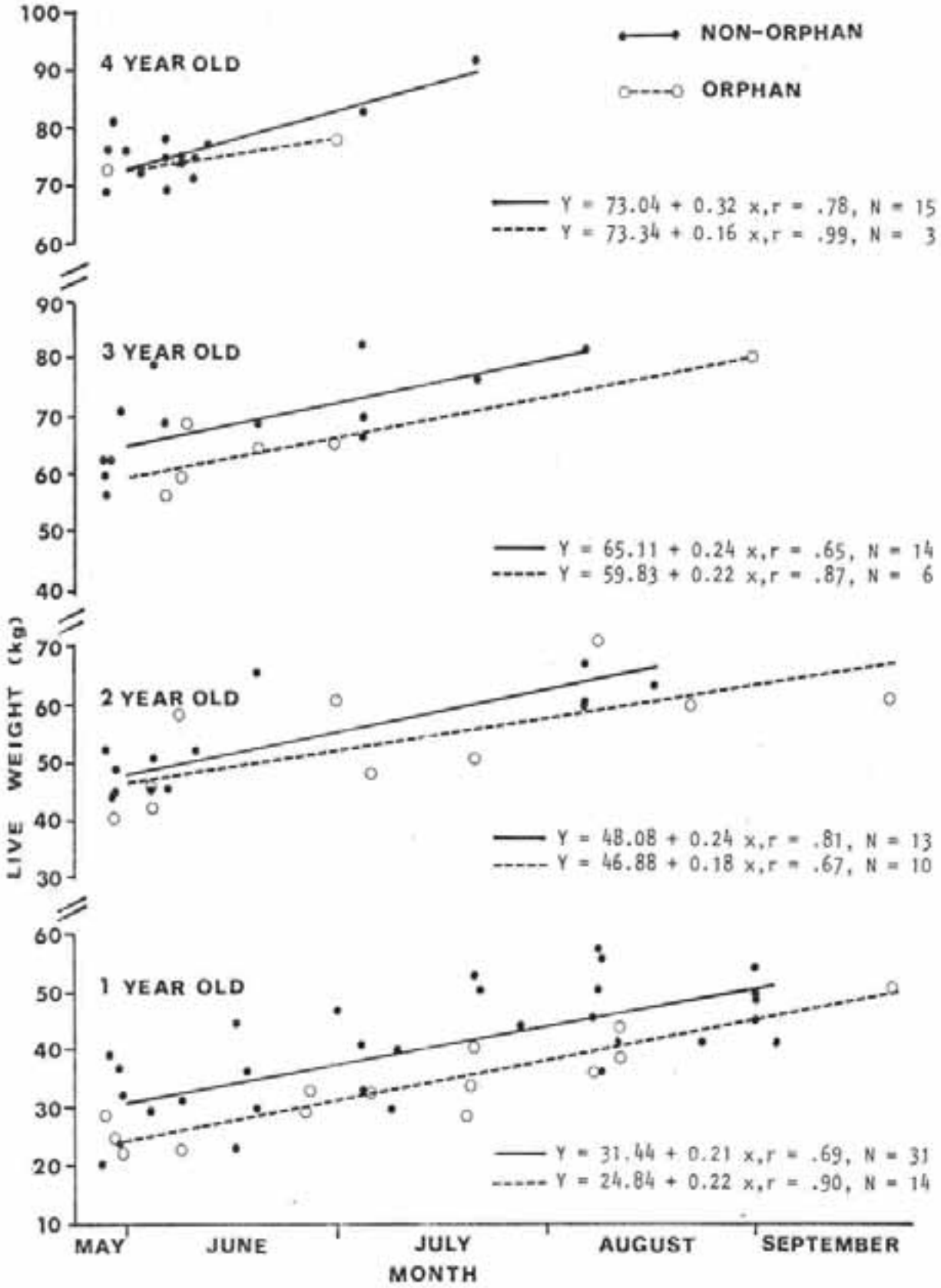

Fig. 3 Live weights of non-orphan vs orphan bighorn rams from Ram Mountain 1975-1977. (June 1 = x_1 for regression lines)

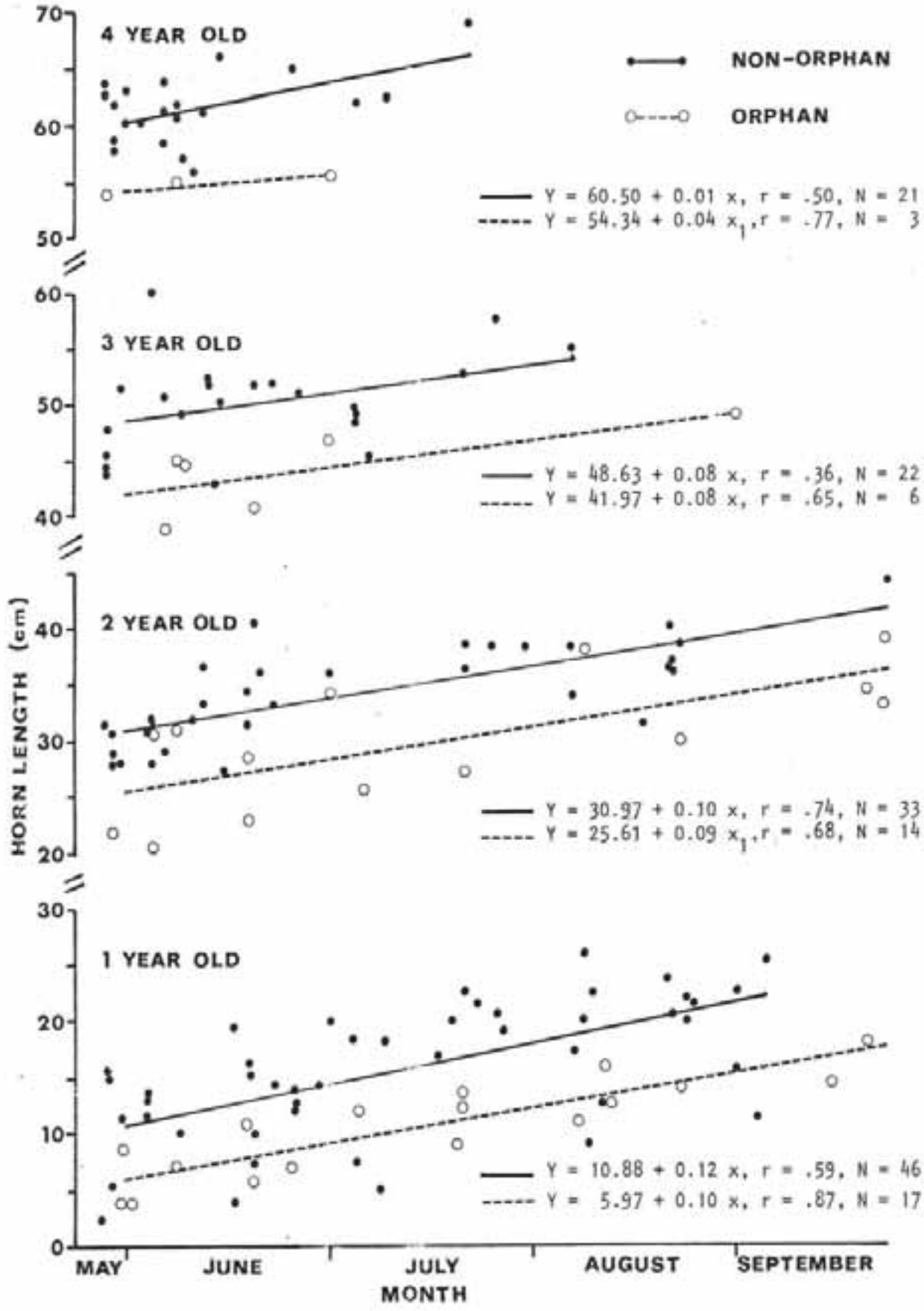

Fig. 4 Horn length measurements of non-orphan vs orphan bighorn rams from Ram Mountain 1971-1977. (June 1 = x_1 for regression lines)

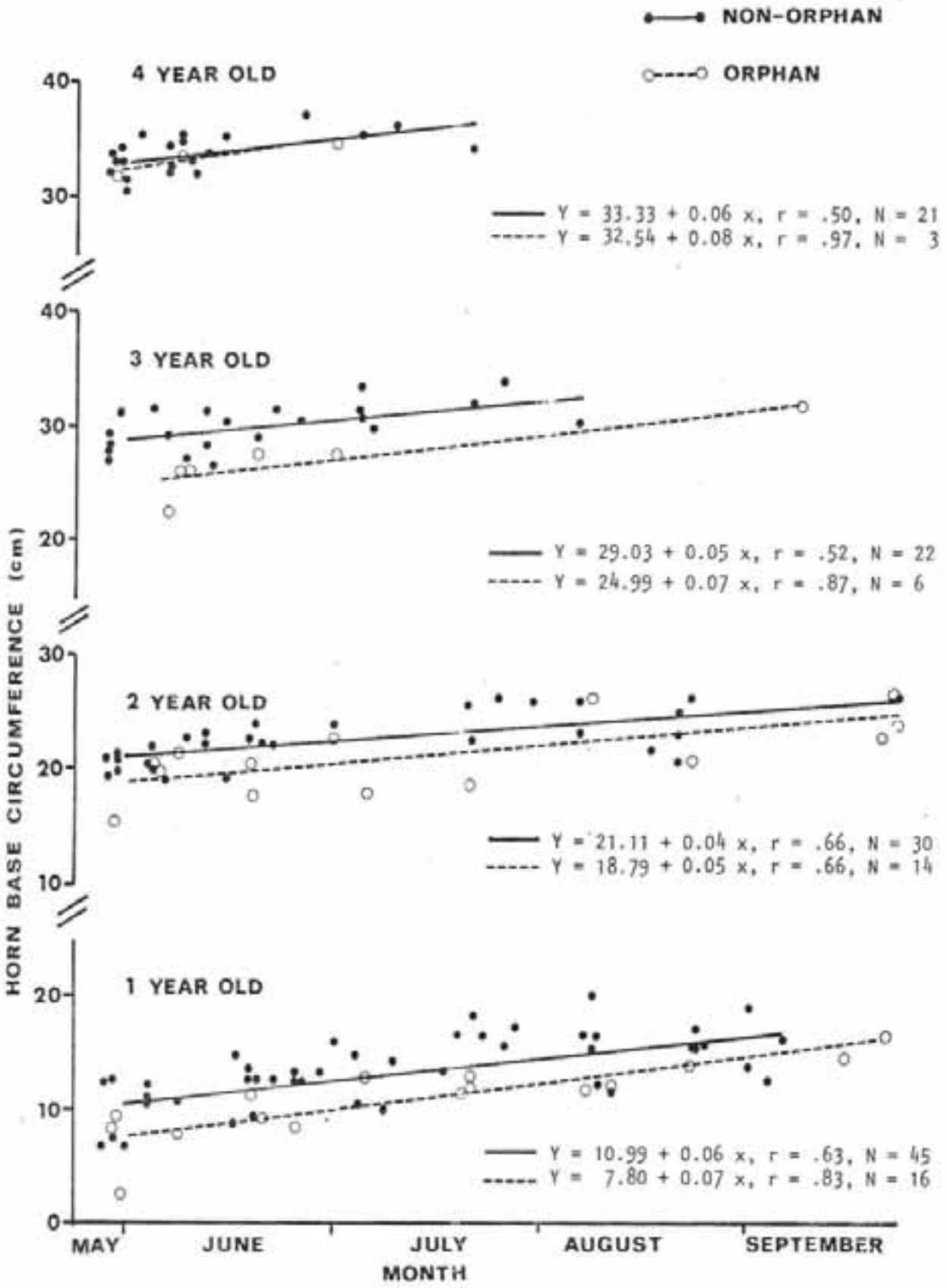

Fig. 5 Horn base circumference measurements of non-orphan vs orphan bighorn rams from Ram Mountain 1971-1977. (June 1 = x_1 for regression line)

Geist (1971) has demonstrated that the female generally remains on the home range of the maternal female group; whereas, the male leaves the group sometime after his second birthday, once he thoroughly dominates females. One would expect large young rams to dominate females and assimilate into ram bands much earlier than smaller rams. Therefore, orphan rams would remain with female groups longer than non-orphans. Table 4 supports this theory based on a comparison of three orphan rams and ten non-orphan rams.

Population Quality and Condition

Geist (1971) and Shackleton (1973) have examined the concept of population quality in bighorns and have indicated certain attributes characteristic of high quality populations such as increased productivity and growth rates. Bighorn ewes usually are not reproductively mature until they are 2½ years old. Two 2-year-old females in the high quality herd (Kootenay) studied by Shackleton were accompanied by lambs in 1970. Horesji (1976) observed 2 year old ewes with lambs in the Sheep River herd and demonstrated that herd to be a high-quality population. This reproductive phenomenon has also been reported by Woodgerd (1964) for an expanding population. One out of six 2 year old ewes on ram mountain had lambs in 1975 and 1976(Table 5). Five out of eight 2-year-old ewes were lactating, but only three were observed with lambs in 1977. The other two lambs suffered mortality before, during, or shortly after parturition. Of the five mothers, three were orphans. Of the three ewes with lambs surviving, one was an orphan.

High lamb production is indicative of a high quality population even though lamb production fluctuates greatly between years (Geist 1971). Over a 7 year period on Ram Mountain, an average ratio of 67 lambs:100 adult ewes (includes 2-year-old ewes with lambs) was realized (Table 6). This is comparable to a ratio of 68 lambs:100 adult ewes (includes 2-year-old ewes with lambs)found at Kootenay by Shackleton (1973) Horesji (1976) indicated a maximum ratio of 87 lambs:100 adult ewes (includes 2-year-old ewes with lambs) at Sheep River in 1972. The low quality herd (Banff) studied by Shackleton (1973) had a ratio of 33 lambs:100 adult ewes. None of the 2-year-old ewes were observed with lambs.

Shackleton (1973) also demonstrated that above-average annual horn increments in high-quality populations, were followed by below-average annual increments later in horn development. The Ram Mountain herd initially grew the second largest annual horn increments of the four populations examined, followed by the smallest increments by the fifth and sixth year (Figure 6);these data support Shackleton's findings. The Redcap herd, which hasn't been hunted since 1972, demonstrates the reverse of that previously described (Figure 6), suggesting that it is in a stable or declining state.

Mean suckle durations on Ram Mountain were comparable to those observed by Horesji (1976) in a high-quality population in southern Alberta (Table 7), and intermediate between the high and low quality populations studied by Shackleton (1973) (Table 8).

Uhazy et.al., (1973) examined fecal samples from six bighorn herds

Table 5. Age-specific lactation rates of bighorn ewes on Ram Mountain (1975-1977).

Age(years)	Percent Lactating (n)		
	1975	1976	1977
2	17(6)	17(6)	63(8)
3	50(4)	83(6)	80(5)
4	57(7)	100(3)	100(4)
5	66(3)	100(6)	66(3)
6	75(4)	100(2)	80(5)
7	75(4)	0(1)	100(1)
≥8	100(5)	100(5)	75(4)
$\bar{x}$	61(33)	76(29)	77(30)

Table 6. Lamb production on Ram Mountain (1971-1977).

Year	Number of Lambs	Number of Reproductively Mature Ewes	Lambs per 100 females (3 years and older)
1971	24	33	73
1972	24	38	63
1973	25	32	78
1974	15	36	42
1975	20	28[a]	71
1976	22	25[a]	88
1977[d]	16	25[b]	64
Total	146	217[c]	67

[a] Includes one 2-year-old ewe which had a lamb.

[b] Includes three 2-year-old ewes which had lambs.

[c] Includes five 2-year-old ewes which had lambs.

d In 1977, 24 of 27 reproductively mature ewes captured were lactating (including five 2-year-olds). Of those 24, only 16 were observed with lambs.

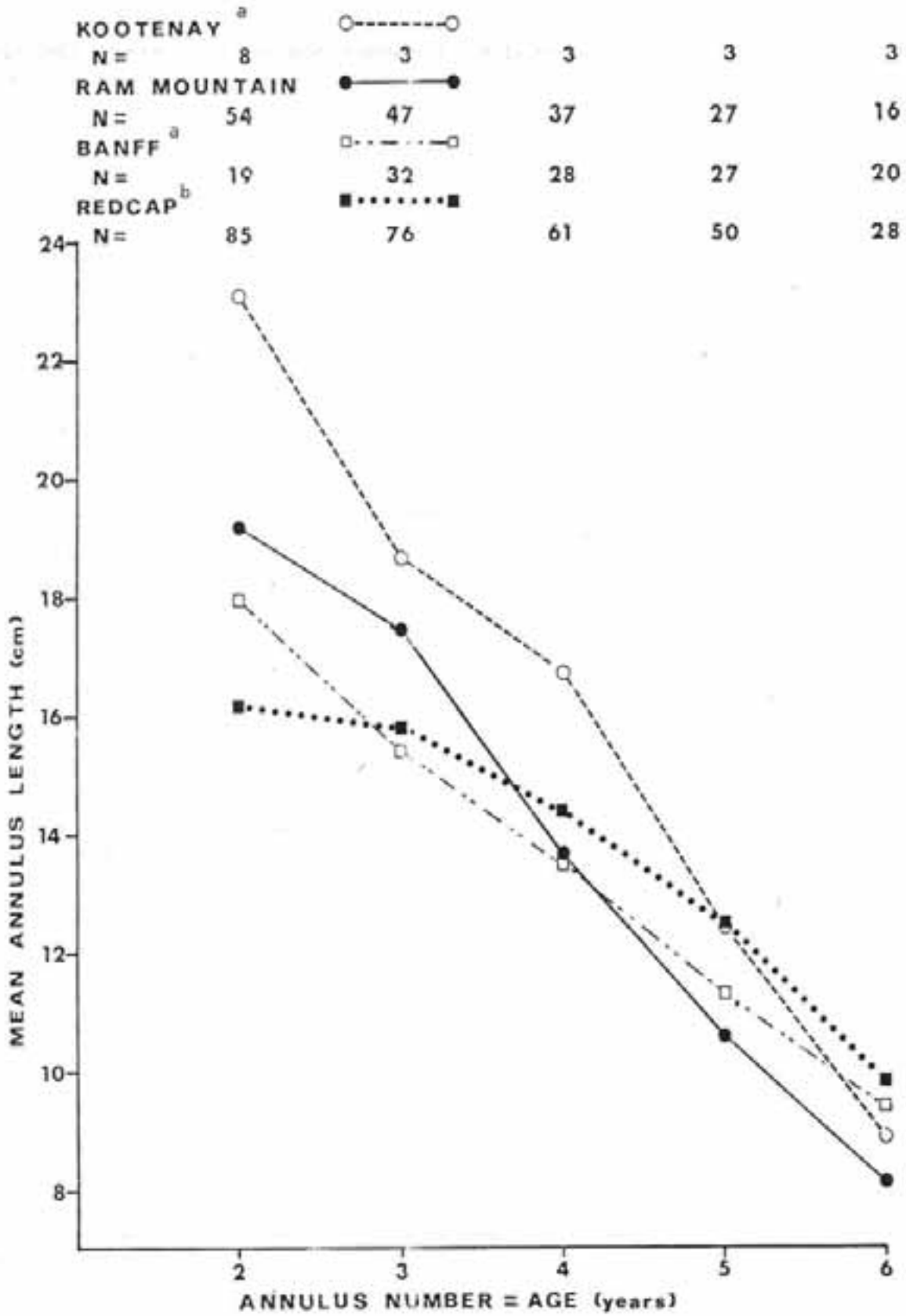

Fig. 6 Mean annual increments (cm) of ram horns from four bighorn sheep populations. By the sixth year of age increments in those populations which had initially shown the longest increments now become the smallest.

[a] Shackleton 1973.

[b] Data from Redcap sheep study - Alberta Fish and Wildlife Div. files.

Table 7. Monthly mean suckle durations from two herds.[a]

Herd	Year	Suckle Durations (Seconds) June	July	August
Sheep River[b]	1969	20.36 ±.513 149	15.9 ±.368 98	14.00 ±.543 22
Sheep River[b]	1970	21.54 ±.583 157	17.25 ± .45 129	14.56 ±.852 9
Sheep River[b]	1972	23.17 ±.981 169	17.43 ±.553 118	15.50 ±1.067 10
Sheep River[b]	1973	20.75 ±1.352 24		
Ram Mountain	1973	17.5 32	16.7 75	
Ram Mountain	1974	22.2 8	13.4 32	
Ram Mountain	1975	24.8 ±1.474 10	18.0 ±1.061 30	
Ram Mountain	1976	19.36 ±1.183 11	15.71 ±.686 18	14.09 ±1.245 11
Ram Mountain	1977	18.00 ±.769 36	15.32 ±.564 31	14.87 ±1.329 8

[a] In seconds, ± standard error and number timed.

[b] Modified from Horesji 1976.

Table 8. Comparison of suckle durations from three bighorn populations.

Population	Observation period	Mean suckle duration (sec)	n	Standard deviation
Kootenay Nat'l Park[a] (high quality)	3/6-25/07/71	28.0	70	13.54
Ram Mountain	21/6-30/07/75	19.7	40	6.25
	6/6-26/07/76	17.1	29	3.73
	1/6-22/07/77	16.7	69	4.21
Banff Nat'l Park[a] (low quality)	4/6-27/07/71	14.1	74	8.22

[a]Modified from Shackleton (1973).

Table 9. Estimates of herd sizes on Ram Mountain (1971-1977).

Year	Estimated Herd Size
1971	96
1972	115
1973	104
1974	106
1975	100
1976	100
1977	95

in Western Canada for lungworm larvae and indicated that fecal examination could provide an index to the proportion of heavy infections in the herd, given a sufficiently large sample size. They demonstrated a significant seasonal variation, with high numbers of larvae shed by bighorns on winter range. Figure 7 illustrates the "spring rise" phenomenon on Ram Mountain (supplemented by data from Sheep River). It appears that larval counts from Ram Mountain are well below the conservative estimate of a heavy infection (1400+ larvae per gram) given by Uhazy et.al., (1973) although conclusions are tentative due to the lack of samples during the spring peak of larval output (sometime between mid-March and mid-May).

Population Dynamics and Harvest

The Ram Mountain herd has remained around 100 animals since 1971 (Table 9). An average of approximately 8.4 per cent of the herd has been harvested annually since 1972 (Table 10). The harvest is comprised of reproductive ewes and rams 4/5 curl or larger. This has resulted in a herd composed of predominantly young age classes (Figure 8). Survival rates are quite high once an animal has lived one year (Table 11). The herd appears to be able to maintain itself under the imposed harvest by increased productivity and high survival rates.

Climatic conditions have been correlated with lamb production and survival (Cowan and Geist, 1971). A negative correlation between cumulative precipitation and lamb production is suggested in Figure 9. Shackleton (1973) has indicated that during the last months of pregnancy the development of the fetus and mammary tissues impose increasingly greater nutritional demands upon the ewe. Deep snow, combined with low temperatures, retard the start of continuous spring growth of vegetation and impose greater energy expenditures on the ewe. This would in turn result in smaller lambs at birth or pre-parturition mortality. Small lambs with poor fat reserves have a reduced chance of surviving inclement weather because of an inability to thermoregulate and gain sufficient nutrition from ewes under such conditions (Shackleton 1973, Horesji 1976).

If one makes the assumption that there is no difference in the chance of trapping a male or female lamb, then the sex ratio of captured lambs can be used as an index to the actual sex ratio. High lamb production appears to result in a sex ratio favoring female lambs (Figure 10). Verme (1969) discussed sex ratio changes of white-tailed deer fawns in relation to the nutritional plane experienced by the doe. He found that 70 per cent of the fawns, born to mothers on restricted rations when bred, were males; whereas, males comprised 47 per cent of the offspring from well-fed deer. He suggested that since deer are polygamous, limited production coupled with a disproportionately large number of male births would markedly depress the herd's annual increment when the range carrying capacity is seriously depleted. But if the habitat is capable of supporting a greater density, high productivity and more female births would result in a rapidly expanding population. The mechanisms which might account for changes in primary sex ratio are at best poorly understood (Nalbandor 1958, cited from Verme 1969). The bighorn situation may be analagous to the above description of sex ratio changes in white-

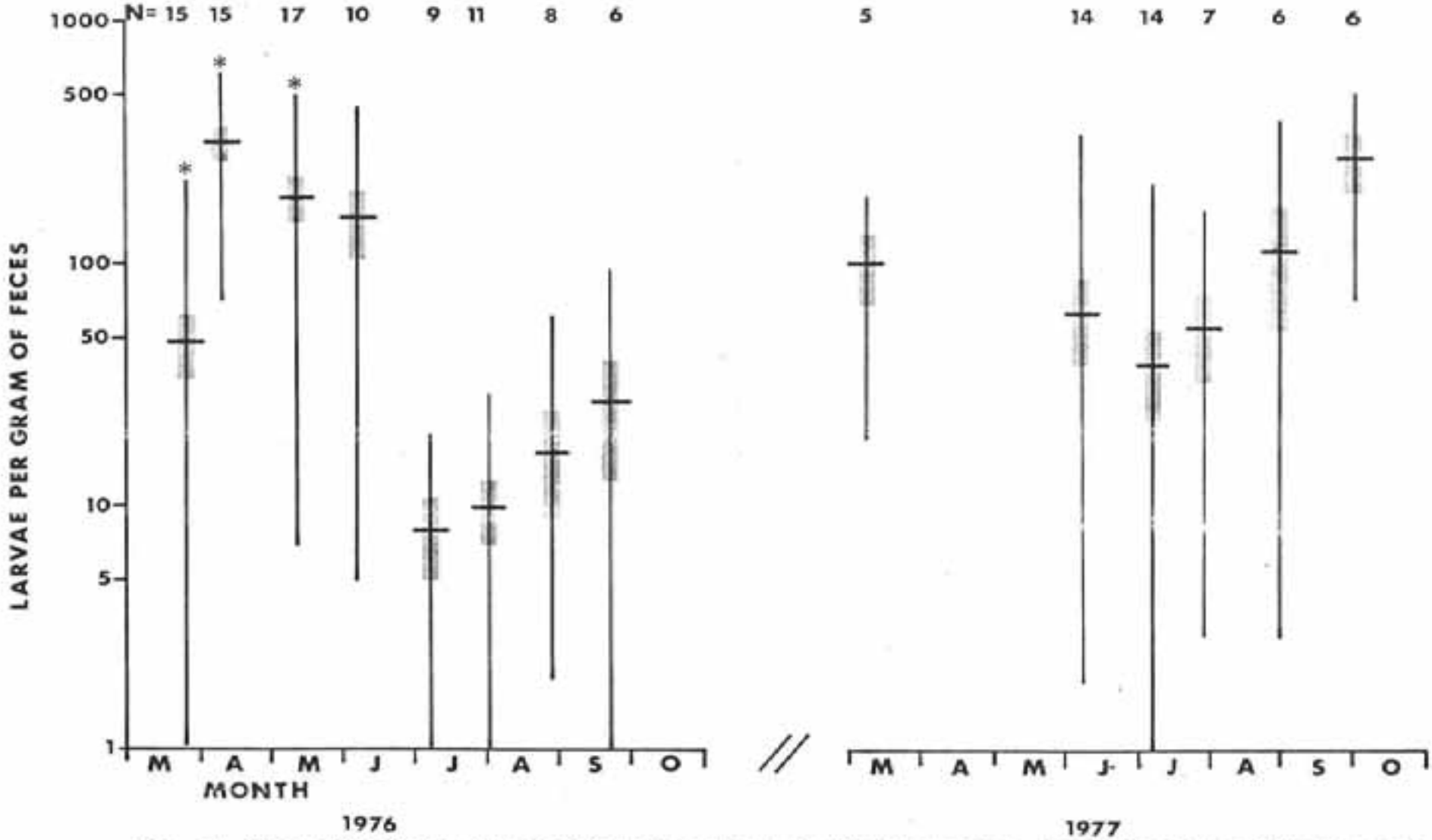

Fig. 7 Mean counts of protostrongylid larvae in bighorn sheep feces from Ram Mountain and Sheep River 1976-77. Means, ranges and ± one standard error are indicated by horizontal lines, vertical lines and shaded boxes respectively.

*Sheep River

Table 10. Number of bighorn sheep harvested on Ram Mountain 1972-77.

Year	Number of Ewes Collected	Number of Rams Harvested	Total Population	Percent of Total Population Harvested
1972	6	3	115	8%
1973	5	2	104	7%
1974	7	0	106	7%
1975	9	1	100	10%
1976	6	4	100	10%
1977	7	2	95	9%
Total	40	12	620	8.4%

Table 11. Survival Rates of Bighorn Sheep from Ram Mountain 1974-77. N = 278.

	Survival Rates (%)							
Cohort	0-1	1-2	2-3	3-4	4-5	5-6	6-7	≥8 years
Rams		.78	.94	.78	.89	.88	.90	.89
			$\bar{x}$ = .86					
	.71							
Ewes		.86	.80	.93	1.00	.92	.87	.93
			$\bar{x}$ = .89					

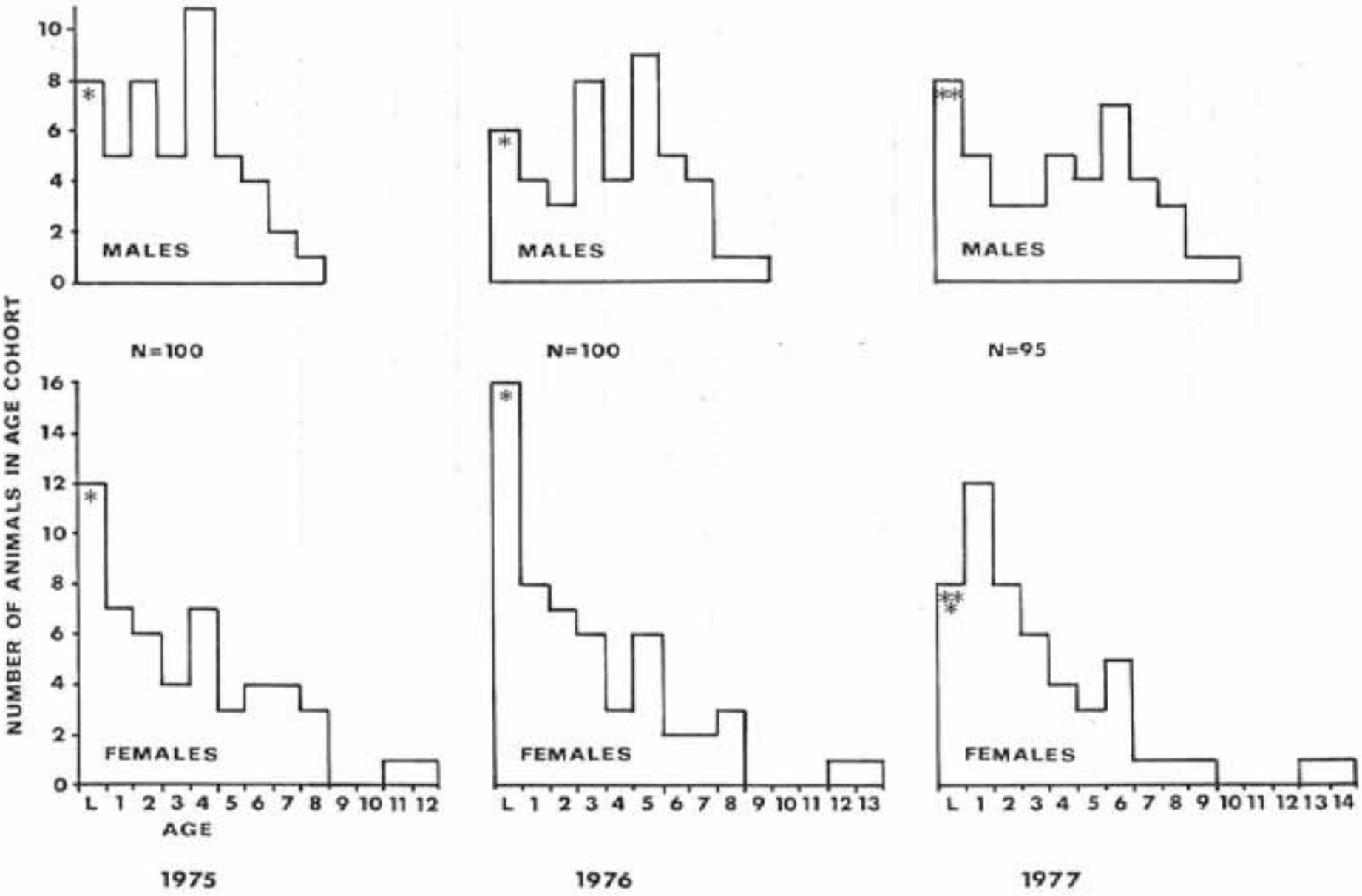

Fig. 8 Sex and age composition of the Ram Mountain bighorn sheep population (1975-77)
* Includes one lamb of unknown sex.
** Includes two lambs of unknown sex.
*** Includes three lambs of unknown sex.

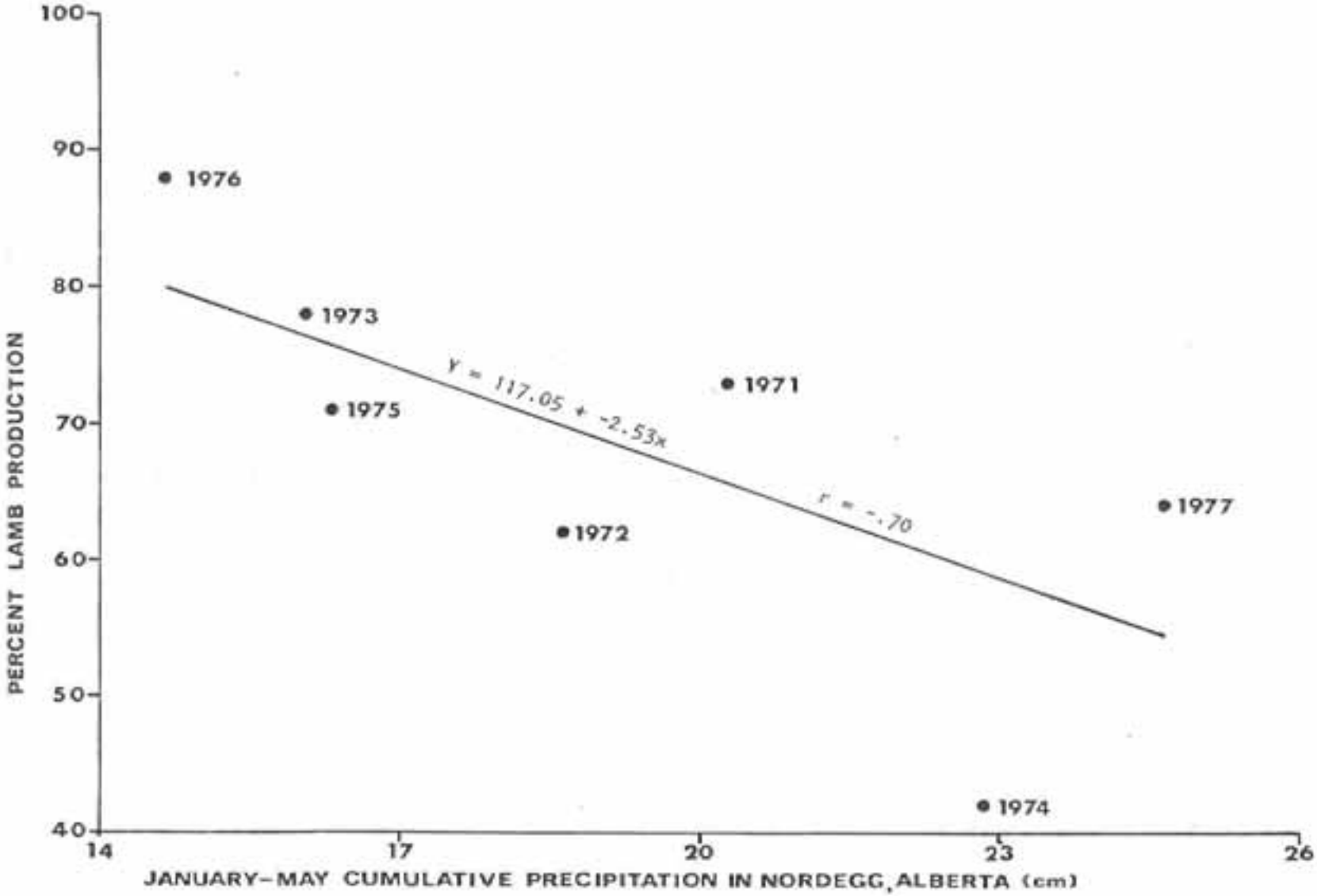

Fig. 9 Comparison of January-May cumulative precipitation in Nordegg, Alberta to lamb production on Ram Mountain 1971-1977. (Nordegg is approximately 25 km north-west of Ram Mountain, and precipitation values are not representative of higher altitudes on Ram Mountain. 1 cm of precipitation roughly equal 10 cm of snow).

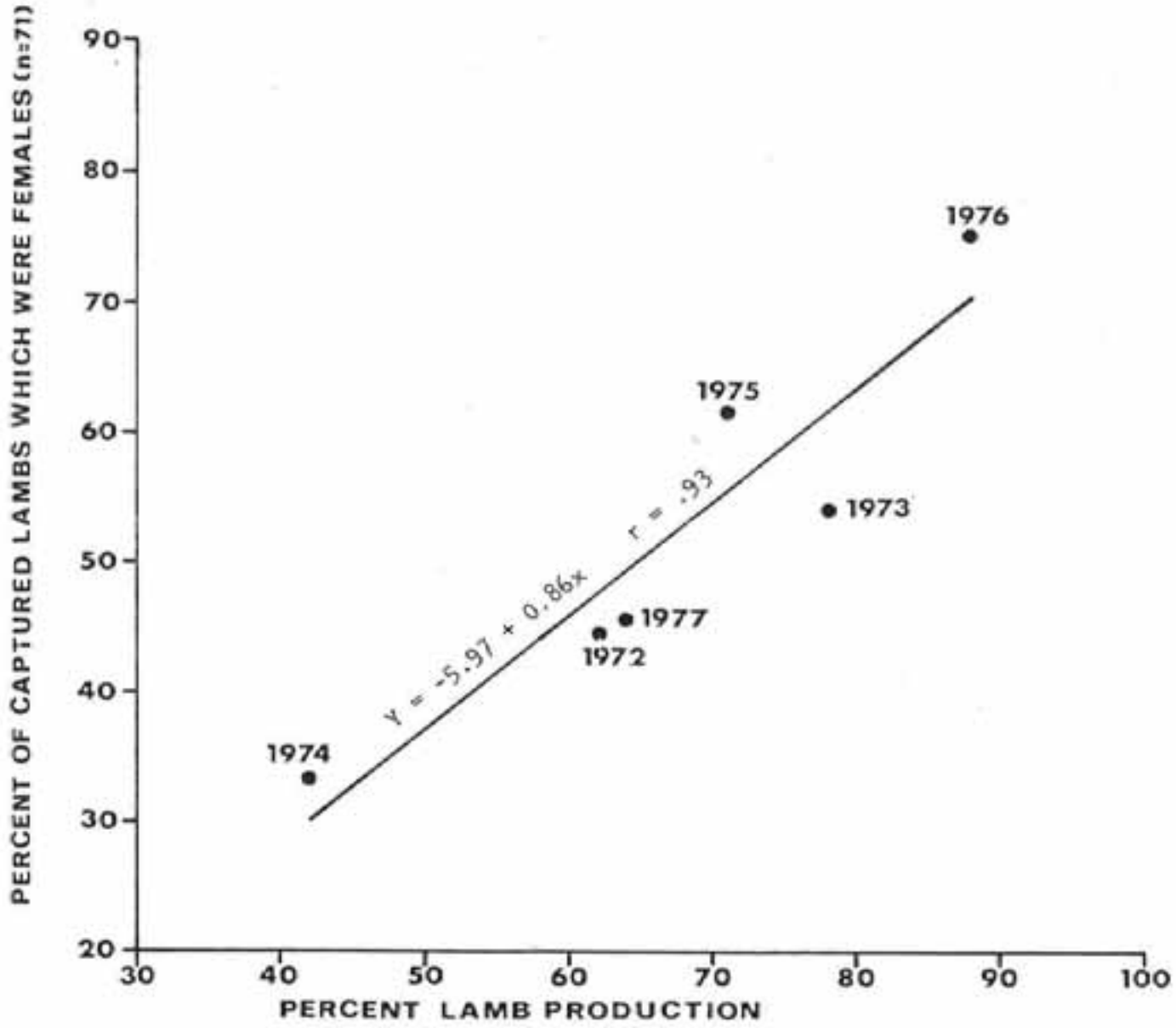

Fig. 10 Comparison of sex ratio of captured lambs to lamb production on Ram Mountain 1972-1977.

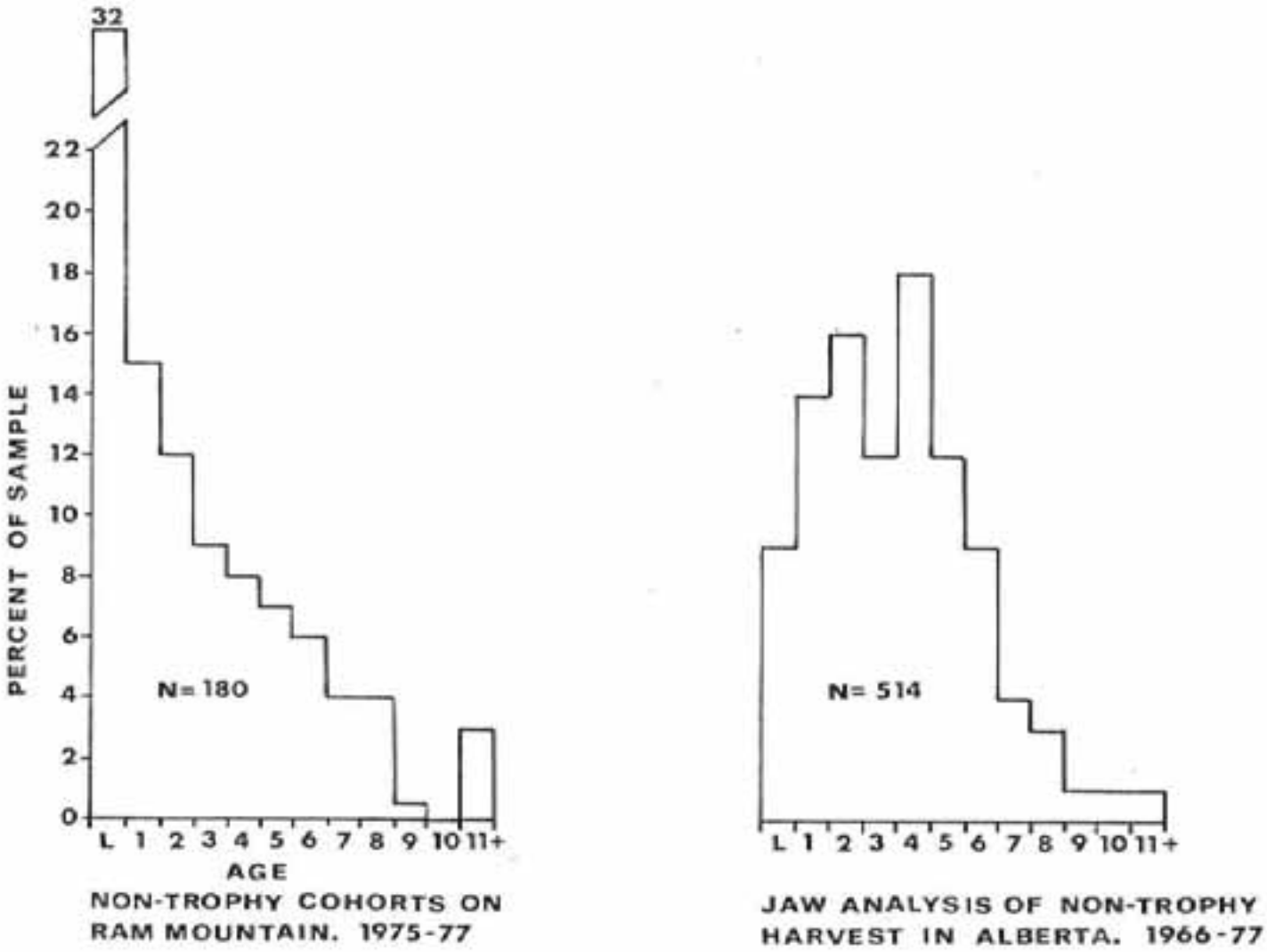

Fig.11 Age composition of non-trophy cohorts on Ram Mtn. (1975-1977) vs non-trophy harvest in Alberta (1966-1977).

tails. The condition of the ewe during the early winter rut would reflect the condition of the summer range, which would influence lamb production and the sex ratio the following year.

PROVINCIAL HARVEST

Certain factors become apparent after imposing provincial harvest rates on the non-trophy age structure of Ram Mountain (Figure11). Hunters are harvesting lambs, yearlings and 2 year old ewes in reverse to their normal occurrence in nature. This would indicate hunter selection against lambs and a slight selection for ewes without lambs as previously reported by Wishart (1976). A harvest rate of about 12 per cent (7 non-trophies and 5 trophies) could be applied to a population such as Ram Mountain on a sustained-yield basis by including lambs, yearlings and 2 year old ewes in the annual harvest of adult ewes and rams.

SUMMARY

The non-trophy season on Ram Mountain has resulted in physical and behavioral stunting of some orphan rams. Rapid horn growth by males in initial years, high lamb production, average suckle durations, low lungworm loads and early maturation indicate the population has developed into and/or maintained itself as a moderately high-quality population. Early maturation has been the most pronounced response, with the number of 2 year old mothers increasing dramatically in 1977.

The herd has stabilized around 100 under an annual harvest rate of 8.4 per cent (the harvest being comprised of reproductive females and rams 4/5 curl or larger). The Ram Mountain sheep herd can sustain an annual harvest rate of 12 per cent when sub adult non-trophy cohorts are included in the harvest as is the case in the provincial harvest. Monitoring climatological information on a yearly basis will assist the wildlife manager in predicting subsequent lamb production and sex ratios.

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WILD SHEEP MANAGEMENT - Chairman: H.B. Mitchell.

K. Becker, Tom Varcalli, E.T. Thorne, and G.B. Butler - Seasonal distribution patterns of Whiskey Mountain sheep.

Bob Jamieson: I was curious if you found:
1) any indications that the rams were moving between the two groups?
2) that there was any impact on the summer ranges?

Tom Thorne: The only ram interchange that we documented was a very few rams on winter ranges during the rutting period, which did move from the BLM ridge area to the Tory Rim. We did not feel that there was a lot of interchange between rams on summer ranges.

With regards to your second question, yes, the Tory Mountain sheep did have an impact on Middle Mountain. I think that that was probably the reason they left in the early summer.

Dave Shackleton: Do you plan to follow up with some of the particularly young rams to see, as they leave the female groups, where they go, which ram groups they go to, to see if this interchange between different areas does occur?

Tom Thorne: Probably the best we'll be able to do on that is follow ear tag returns. We put on an average of about 50-75 neck bands a winter, primarily on ewes.

Tim Baumann: Tom, at what elevations were the summer and winter ranges?

Tom Thorne: Summer range occurred between 10 to 12 thousand feet; winter range occurred around 8 thousand feet.

R.A. Demarchi - Evolution of Mountain Sheep Horn Curl Regulations in British Columbia.

Tim Baumann: In the field you use the cross-hairs to determine whether or not the animal was 7/8 curl. How does the hunter determine with regularity whether or not the animal is six years of age or over?

Ray Demarchi: It has been suggested that we shouldn't be using the horn curl regulation; we should just use a minimum age. The hunter should be educated to determine a class 4 ram from a class 3. Most hunters pass up rams that are of doubtful size and we haven't noticed a major shift in the age class distribution of our kill.

Bill Wishart: What do you do with rams that have been caped out?

Ray Demarchi: We have not explained to the hunter why they should keep the eye socket intact. According to the definition, the less eye socket they leave, the higher the line. If they cut the eye socket right up to the skull plate the horn must be about an inch longer.

Bill Wishart: From actual photos of Bighorns, I get the impression that it does go through the bottom of the eye.

Ray Demarchi: No, it doesn't go through the open eye ball, because once you take the eye out of the socket and expose it then it does go through the eye socket.

Gene Schoonveld: In Colorado's regulations, half the state goes 3/4 curl, the other half is 1/2 curl. Do you feel we have significant mortality on 1/2 curl animals, and is it justifiable to remain at 3/4 curl?

Ray Demarchi: Mortality is fairly low in yearlings compared to other ungulate populations, such as elk. The lower you set your limits when you are hunting these things the more animals you make available to the hunters and the greater chance you have of over-exploitation of whatever class you are shooting for in your population. These are the kinds of safety factors built into game management that we should exploit.

Clarence Tillenius: What was the precise number of rams taken last year in B.C.?

Ray Demarchi: I don't have it at my finger tips, but we have compulsory reporting now, and I think we are checking about 95% of the sheep.

W.E. Heimer - Alternate year production in low quality, declining Dall sheep populations: management considerations.

Dave Shackleton: Have you looked at the condition of the summer range as it affects lactation or fat deposition?

Wayne Heimer: In a classical sense, no. Under summer conditions in Dry Creek there seems to be no shortage of vegetation. However, Dry Creek is a small drainage, and there is little to be gained by chasing emerging vegetation altitudinally or up the valley because it happens all in two weeks, at the most. So that is probably limiting to an extent.

John Gibson: In your 30% lamb production, what is the ratio between ewes and rams? On the farm we get nine rams for every ewe in the newborn, in our Dall sheep.

Wayne Heimer: The ratio of rams to ewes in the population is very much skewed in favour of ewes. We have 65 or 70% ewes.

Rick Ellis: You seem to consider the alternate year production as fixed. It seems to me that the strategy is probably linked somehow to the amount of available food per female, and could change with range conditions fixed.

Wayne Heimer: No, I don't have any reason for assuming that it is fixed. It appears, in higher quality populations, that annual reproduction is probably the key.

E. T. Thorne, T. Varcalli, K. Becker and G.B. Butler - Some thoughts on the consequences of non-trophy sheep hunting in the Wind River Mountains of Wyoming.

Bill Wishart: At some point you will no longer be able to transplant sheep. What do you anticipate?

Tom Thorne: We don't really know. My suggestion would be that we could trap ewes and lambs and slaughter them if we had to. Tom Varcalli suggested that we have a two day season in the winter, when they are all on the winter ranges, or have a season every two years and kill more sheep each time.

Bill Wishart: Possibly your winter ranges could be a sanctuary in the sense that nobody hunts there.

Tom Thorne: There would be a danger that, in time, using the winter range as a sanctuary, we would end up with a non-migratory herd.