BEHAVIORAL DIFFERENCES IN BIGHORN LAMBS (*Ovis canadensis canadensis* Shaw) DURING YEARS OF HIGH AND LOW SURVIVAL

Brian Horejsi
Department of Biology
University of Calgary
Calgary, Alberta

Introduction

The hypothesis that there are measurable differences between populations in different stages of development, for example growing versus declining, is an old one. According to Chitty (1955) it was Young (1868) who first suggested it.

These differences have been demonstrated using morphological and reproductive characteristics, as Klein did in his work with black-tailed deer (*Odocoileus hemionus sitkensis*) (1964) and reindeer (*Rangifer tarandus*) (1968).

Behavioral parameters have also been considered as indicators of population status. Chitty (1955) recognized their value but was not able to quantify differences. More recently Geist (1971) showed that between populations of different species of mountain sheep (*Ovis* spp.) there were certain aspects of behavior that were quantitatively different and that these differences could be attributed to differences in the 'quality' of a population, i.e. expanding or declining.

This study was undertaken to test the hypothesis that, although there may be a definite trend in a population and therefore it could be classified as either expanding, stable or declining, there may be considerable between year differences in behavior within the population. The study was conducted in the Sheep River area of southwest Alberta during the summers of 1969 and 1970, a period over which the population slowly increased despite heavy hunting pressure.

The objectives of the study were to quantify certain aspects of ewe and lamb behavior and analyze any differences in terms of their possible influence on lamb survival.

Emphasis was on ewes and lambs because they were the 'producing' segment of the population and had not previously been studied intensively. In addition it was thought an analysis of their behavior might provide an efficient means by which to evaluate both the yearly, and as Geist suggested, the longer term status of the population.

In retrospect the choice of years was most fortunate for in 1969 lamb survival was low and in 1970 it was high (Table 1).

The late spring ewe : lamb ratios from the two years represent close to the extremes that might be expected. Wishart (1958), working with this same herd, reported ewe : lamb ratios, in May, of 100:92, 100:77, and 100:70 in 1955/56/57 respectively. The first values indicate exceptionally high lamb survival, much as Woodgerd (1964) found in a rapidly expanding population. He found a ewe : lamb ratio of 100:91 six months or more after lambing. Berwick (1968) whose study population was declining reports ratios of 100:31 and 100:75 in winter and Morgan (1970), who also worked with declining populations, found ewe : lamb ratios as low as 100:8 and 100:12 in mid-winter.

Equally as important as late spring ratios are those from July. These indicate that, in terms of fertility , both years were probably equal (Table 1).

A number of different classes of behavior were quantified in the course of the study. Amongst these were time spent feeding vegetation (FV), intensity of FV, FV effort, time spent 'active' (on their feet) and time spent bedded. This data was collected from both ewes and lambs. Additional observations of events which occurred during suckling interactions were recorded and will be discussed shortly.

Data on FV activity was collected in an effort to get an estimate of the relative abundance and/or quality of forage available to the grazing sheep. In the agricultural literature there are a number of works relating forage quality or quantity to grazing time.

Amongst these works are those of Arnold (1960, 1963, 1964) in which he found that there was a significant negative correlation between the grazing time of domestic sheep and pasture availability measured in pounds of green dry matter per acre. He reported grazing times varied from 7 hours on pasture producing 2250 lbs/acre to 10.5 hrs. on pasture producing about 650 lbs/acre. Increased stocking rates increased grazing time due to decreased forage availability.

Allden (1962) reports a strong inverse relationship between grazing time and the amount of dry green herbage available in a pasture providing less than 3000 lbs of dry matter per acre. In a later paper Allden and Whittaker (1970) conclude that sheep are partially able to compensate for a reduction in the amount of herbage available by increasing grazing time. They found grazing times varying from 6 to 13 hours on pastures producing 2670 lbs and 445 lbs of dry matter per acre, respectively.

It is also commonly reported that grazing times increase with advancing forage maturity, i.e. decreasing quality and availability. Hancock (1954) and Wagnon (1960) report this relationship holds true for dairy cattle and beef cattle in New Zealand and California respectively. A number of other North American investigators have also commented on this while studying the grazing behavior of cattle (Sneva, 1970; Compton and Brundage, 1971) and domestic sheep (Bowns, 1971) although they, like myself, present no quantitative data on forage quality.

It is of course recognized that there are a number of other factors which may affect grazing time indirectly by affecting rate of intake. Some of these factors, which are extremely variable and most difficult to measure, are plant height, physionomy and spacing, the size of bite the animal takes and the rate at which it bites (Arnold, 1963; Allden and Whittaker, 1970). Our understanding of their effects on grazing time is negligible.

Activity of Females

Excluding July, ewes in 1969 spent more time FV than those in 1970. In July the opposite was true but not to the same degree as in other months (Table 2).

In 1970 ewes fed less intently than those in 1969 (Table 3).

Combining the time spent feeding and the intensity with which the animals fed, I calculated FV effort which, in short, gives the percentage of time the animal spent actually ingesting vegetation.

It is obvious from Table 4 that the feeding effort of ewes in 1969 was considerably greater than that of ewes in 1970 -- for that

matter approximately twice as great. On the basis of the generalized relationship between forage quality/quantity and grazing time, I concluded that in 1970 forage conditions were more favorable for the bighorns than in 1969.

In addition to differences in FV, there were differences in time 'active' and time spent 'walking'. Ewes in 1970 were generally more 'active' than those in 1969, again excepting July and they spent more time walking (Table 5).

Activity of Lambs

Lambs in 1970 spent less time FV than did lambs in 1969 (Table 6). The former also fed less intently than the latter (Table 7).

The result was a FV effort in 1970 considerably smaller, particularly in July, than in 1969 (Table 8).

In each month of 1970 lambs spent much more time 'walking' than did lambs in 1969. Lambs were also more 'active' in June and August of 1970 than lambs in the same months of 1969 (Table 9). In July lambs in 1969 were more active than those in 1970 but the difference was small compared to the differences, in favor of 1970, in other months. This data on time 'walking' and 'active' suggests to me that lambs in the "high survival" year of 1970, who spent more of their 'active' time 'walking' (Table 10), were more vigorous than lambs in 1969. Walking includes running, most of which occurred during 'play'.

Nursing and Suckling Behavior

A considerable amount of research has been conducted on the effects of nutrition on milk production and lamb growth in domestic sheep (Wallace, 1948; Barnicoat, Murray, Roberts and Wilson, 1956). It is now well accepted that: 1) a low plane of nutrition results in poor milk production, and 2) rate of growth of lambs is largely dependent on the amount of milk consumed.

I had no direct means of measuring milk production and therefore I relied on observations of the duration and frequency of suckling in an effort to determine whether there was a difference between the two years. Ewbanks (1967) has shown that amongst single domestic lambs there is almost a linear relationship between suckling rate (no. of suckles per unit of time) and weight gain. Since, as I have mentioned, weight gain of lambs is directly dependent, at least for the first 6 weeks, on milk consumed, a high suckling rate would suggest high milk production. In addition, I recorded several other events which I felt would indicate to what degree a lamb was being satisfied.

As Table 11 shows suckling durations were longer in 1970 than in 1969 although the only significant difference is in the last two weeks of July. Table 12 shows that, excepting the first two weeks in July, lambs in 1970 also suckled more frequently than those in 1969. Calculations of the total number of seconds suckled per 24 hours (Table 13) shows that, with one exception, lambs in 1970 spent more total time suckling than did those in 1969. Figure 1 shows this graphically.

This data suggests that, in general, lambs in 1970 may have received more milk (assuming total suckling time is related to milk intake) than those in 1969. Perhaps more important than this is the high number of seconds suckled in late July and early August of 1970. The implication is that lactation in 1970 did not drop off as rapidly

as it did in 1969, a pattern characteristic of domestic ewes on a high plane of nutrition (Barnicoat, Logan and Grant 1949).

Geist (1971) suggested that lambs in an expanding or growing population, which he termed a high quality population, would attempt to suckle less and be rejected less than lambs from the opposite "type" of population, that is a stable or declining population. He presents data in support of this hypothesis, showing that "low quality" bighorn lambs in their second and third weeks of life were refused an average of 39 per cent of their suckle attempts while "high quality" Stone's lambs of the same age were refused in only 17 per cent of their attempts. The bighorns attempted to suckle 4.3 times/hour of ewe activity at three weeks of age while, at the same age, the Stone's lambs attempted to suckle only 3.5 times/hour of ewe activity.

I found in the high survival year of 1970/71, as opposed to 1969/70, that: a) lambs attempted to suckle more often per hour of ewe activity (Table 14), and b) a greater percentage of their attempts were refused, considering monthly totals only, in all but August. Considering two-week periods however, only in July were lambs in 1970/71 refused a greater percentage of the time than lambs in 1969/70 (Table 15).

This data suggests that the more lambs suckle the more times they will attempt to suckle or conversely, the more they attempt to suckle, the more they do suckle. These findings are contrary to those of Geist (1971).

The type of approach that a lamb makes to a ewe when intending to suckle is another means by which the observer can judge the stage and rate of development of lambs. Lambs use two basic types of approach during successful suckling intereactions: the "run-around" approach, in which the lamb passes immediately in front of the ewe, often rubbing up against her chest. This action often brings the ewe to a stop and the lamb then continues around to the udder.

The second type of approach is the "step-in" during which the lamb does <u>not</u> pass immediately in front of the ewe but instead takes the shortest possible route to the udder. Unlike the "run-around" it does not facilitate suckling by bringing the ewe to a stop, even momentarily.

The "run-around" approach is used more as a lamb grows older and larger (Table 16).

It seems reasonable then, to assume that lamb size is an important factor in the "run-around" approach, a large lamb being more likely to stop or "hold" a ewe than a small lamb. A reflection of the rate of growth of lambs would then be the rate at which the use of this type of approach increases. In 1970 the rate of increase of run-around approaches was greater than in 1969 and, in terms of the point at which this type of approach equals the occurrence of step-in approaches, I judged lambs in 1970 to be from 3 to 4 weeks ahead of lambs in 1969 (Figure 2).

In 1970, the only year for which I have the type of data that follows, the "step-in" approach was used during 58 per cent (n = 81) of 140 unsuccessful suckle attempts while the "run-around" approach was used in only 42 per cent of the unsuccessful attempts, making the latter clearly the more effective.

The last aspect of ewe-lamb relations I will comment on is the method which ewes use to terminate suckling events. Since it is uncommon for a lamb to quit suckling on its own, the initiative to terminate falls on the ewe.

Two main categories of termination were recognized -- contact and non-contact terminations. Contact terminations are those in which the ewe makes physical contact with the lamb. The "step-through" method of termination, in which the ewe simply walks forward and pushes the lamb with its leg, causing it to "break loose" from the udder, composes 98 per cent (n = 240) of all terminations in this group.

Non-contact terminations include those in which the ewe breaks the lamb's grip on the udder without physically contacting the lamb. The "step-over" method, in which the ewe lifts her foot over the lamb and the "turn-away" method compose 81 per cent (n = 335) and 15 per cent (n= 64), respectively, of all non-contact terminations.

I am of the opinion that the frequency of occurrence of contact and non-contact terminations reflects the size of lambs. As I mentioned previously in the "step-through", the ewe simply forces the lamb out of the way. This is possible as long as the lamb is small enough to be moved; however at a "certain" lamb size it becomes difficult for the ewe to move the lamb. It then begins to "step-over" or "turn-away" from the lamb. In Figure 3 the relationship between contact and non-contact terminations can be seen.

The important features of this graph are the points at which non-contact terminations finally equal or surpass contact terminations in frequency. The data show that in 1970 lambs reached that "certain" size about one month before lambs in 1969 did.

Conclusions

The conclusions I have drawn from the observations presented are:

a) bighorns in 1970 expended less energy on foraging due to greater quality and/or quantity of forage, than did bighorns in 1969.
b) that lambs in 1970 may have been more dependent on milk than lambs in 1969 probably because there was more of it available, and
c) that in the high survival year of 1970/71 lambs exhibited certain characteristics that suggested they were larger than lambs in 1969.

Although there are parts of the data that do not support my conclusions the majority of the evidence does and I strongly suspect that the factors I have discussed were associated with the different rates of lamb survival in the 2 years.

Acknowledgments

I wish to acknowledge the Department of Biology, University of Calgary for financial assistance and the Environmental Sciences Centre, University of Calgary for providing essential equipment. My thanks also go to Dr. V. Geist, Department of Environmental Design, University of Calgary, for financial assistance via a National Research Council Grant and for constructive criticism of this paper.

Literature Cited

Allden, W.G. 1962. Rate of herbage intake and grazing time in relation to herbage availability. Proc. Australian Soc. Anim. Prod. 4: 163-166.

Allden, W.G. and Whittaker, I.A. 1970. The determinants of herbage intake by grazing sheep: The interrelationship of factors influencing herbage intake and availability. Aust. J. Agric. Res. Vol. 21: 755-766.

Arnold, G.W. 1960. The effect of the quantity and quality of pasture available to sheep on their grazing behavior. Aus. J. Agric. Res. 11 (6): 1034 - 1043.

_____. 1963. The grazing behavior of sheep. Wool Technology and Sheep Breeding. Vol. 10 (1): 17-19.

_____. 1964. Factors within plant associations affecting the behavior and performance of grazing animals. In D.J. Crisp (Ed.) Grazing in terrestrial and Marine environments. Blackwell Scientific publications: 133-154.

Barnicoat, C.R., Logan, A.G., and Grant, A.I. 1949. Milk Secretion Studies with New Zealand Romney Ewes. Part II. J. Agric. Sci. Vol. 39 (1): 47-55.

Barnicoat, C.R., P.F. Murray, E.M. Roberts and G.S. Wilson. 1956. Milk secretion studies with New Zealant Romney ewes. Part VI. J. Agric. Sci. 48 (1): 12-18.

Berwick, S.H. 1968. Observations on the decline of the Rock Creek, Montana, population of bighorn sheep. Master's thesis, Univ. of Montana, Missoula 245 pp.

Bowns, J.E. 1971. Sheep behavior under unherded conditions on mountain summer ranges. J. Range Mgmt. 24 (2): 105-109.

Chitty, D. 1955. Adverse effects of population density upon the viability of later generations. In Cragg, J.B. and Pire, N.W. (Eds.) The numbers of men and animals. Oliver and Boyd: 57-67.

Compton, T.L. and A.L. Brundage. 1971. Cattle behavior on subalpine range in south-central Alaska. J. Anim. Sci. 32 (2): 339-342.

Ewbanks, R. 1967. Nursing and Suckling behavior amongst Clun Forest ewes and lambs. Anim. Behav., 15: 251-258.

Geist, V. 1971. Mountain sheep: A study in behavior and evolution. Univ. of Chicago Press. 383 pp.

Hancock, J. 1954. Studies of grazing behavior in relation to grass-land management. Part I. J. Agric. Sci. 44: 420-429.

Klein, D.R. 1964. Range related differences in growth of deer reflected in skeletal ratios. J. Mamm. Vol. 45 (2): 226-235.

Klein, D.R. 1968. The introduction, increase, and crash of Reindeer on St. Matthew Island. J. Wild. Mgmt., Vol. 32 (2): 350-367.

Morgan, J.K. 1970. Ecology of the Morgan creek and east fork of the Salmon River bighorn sheep herds and management of bighorn sheep in Idaho. Res. Comp. Report., Idaho F & G Dept. 155 pp.

Sneva, F.A. 1970. Behavior of yearling cattle on Eastern Oregon ranges. J. Range Mgmt. 23 (3): 155-158.

Wagnon, K.A. 1963. Behavior of beef cows on a California range. Bull. 799. California Agric. Exp. Sta. 58 pp.

Wallace, L.R. 1948. The growth of lambs before and after birth in relation to the level of nutrition. Part I. J. Agric. Sci. 38 (2): 93-153.

Wishart, W.D. 1958. The bighorn sheep of the Sheep River Valley. Master's thesis, Univ. of Alberta, Edmonton. 66 pp.

Woodgerd, W. 1964. Population dynamics of bighorn sheep on Wildhorse Island. J. Wild. Mgmt. 28 (2): 381-391.

Brian Horejsi - Question Period

Q. Have you any observations on how long nursing continued during these two years?

A. Yes, in both years it continued into January. Mind you, at that stage it is very infrequent but it did continue into January. I also saw yearlings suckling at this time.

Q. Did you make any observation of any dry weight forage, of what was available?

A. No, I didn't make any measurements on the amount of forage available.

Q. Did you make any measurements of what was the difference in spring growth - plants, not grasses?

A. Of course, I am sure that is what caused the effect in the differences in feeding between vegetation, effort and time. In the spring of 1970 there was very heavy snowfall in April and March of that year and temperatures in July of 1970 were significantly warmer than in 1969. I think that there was more moisture available in 1970 and it improved more rapidly in warmer temperatures.

TABLE 1. Lambs per 100 females*, 1969-1970, Sheep River Area.
(n = number of ewe and lamb days).

	1969/70 (n)	1970/71 (n)
June	78 (121)	75 (185)
July	84 (153	85 (242)
August	56 (56)	85 (76)
September	27 (71)	--
October	--	63 (70)
November	23 (163)	--
December	25 (280)	70 (52)
January	38 (36)	--
February	20 (425)	56 (53)
March	12 (171)	--
April	19 (217)	--
May	15 (38)	72 (55)
June + July + August	76 (330)	81 (503)
September to May	21 (1401)	64 (230)

* No correction for 2 yr. old or barren ♀♀.

TABLE 2. Percent of observation time grazing and number of hours spent grazing per 24 hours., females.

	1969		1970	
	%	hours	%	hours
June	28	6.72	16	3.84
July	14	3.36	16	3.84
August	29	6.96	19	4.56
September	32	7.68	--	---
June-July-August	22	5.28	16	3.84

TABLE 3 . Intensity of Feeding Vegetation (FV) by females, 1969 and 1970, in minutes FV per 100 minutes active.

	Feeding Vegetation Intensity			
	1969	(n)	1970	(n)
June	80.3	(13)	65.3	24)
July	----		59.7	(9)
August	61.3	(14)	----	
July-Aug.	----		56.8	(12)
Sept.-Nov.	65.3	(13)	----	

(n) = number of ten minute observation periods

TABLE 4 . Feeding Vegetation Effort (% of time actually spent ingesting vegetation), bighorn ewes, 1969 and 1970.

	Feeding Vegetation Effort	
	1969	1970
June	22.48	11.09
July	----	9.55
August	17.78	----
July-Aug.	-----	9.08
Sept.-Nov.	20.90	----

TABLE 5 Percent of time females were 'active' and the percent of time they spent 'walking', 1969 and 1970.

	Active		Walking	
	1969	1970	1969	1970
June	47	59	6	8
July	67	51	7	7
August	56	69	6	13
September	58	--	7	-

TABLE 6 . Percent of observation time lambs spent Feeding Vegetation and number of hours FV/24 hours.

	% of time FV		Hrs. FV/24 hrs.	
	1969	1970	1969	1970
June	10	8	2.40	1.92
July	13	11	3.12	2.64
August	22	20	5.28	4.80
September	31	--	7.44	----

TABLE 7 . Intensity of Feeding Vegetation by lambs, 1969 and 1970, in minutes FV per 100 minutes active.

	Feeding vegetation Intensity			
	1969	(n)	1970	(n)
June	34.5	(36)	28.0	(40)
July	51.3	(40)	29.8	(45)
August	48.3	(23)	43.3	(9)
Sept.-Nov.	68.7	(17)	-- -	

(n) = number of ten minute observation periods

TABLE 8 . Feeding Vegetation Effort (% of time actually spent ingesting vegetation), bighorn lambs, 1969 and 1970.

	Feeding Vegetation Effort	
	1969	1970
June	3.45	2.24
July	6.67	3.28
August	10.61	8.66
Sept.-Nov.	21.30	----

TABLE 9 . Percent of time lambs were "active" and the percent of time they spent 'walking', 1969 and 1970.

	Active		Walking	
	1969	1970	1969	1970
June	34	47	5	11
July	45	43	6	9
August	50	63	6	11
September	59	--	6	--

TABLE 10 'Walking'as a percent of time 'active', bighorn lambs, 1969 and 1970.

	1969	1970
June	15	23
July	13	21
August	12	17

TABLE 11. Duration of suckles by bighorn lambs, 1969 and 1970, Sheep River Area.

		Suckle Duration (sec.) 1969	(n)	1970	(n)	Significance of difference
June	1 - 15	20.2	(102)	----		
	16 - 31	20.1	(48)	21.5	(157)	$p < .10$
	total	20.2	(150)	21.5	(157)	$p < .10$
July	1 - 15	15.6	(87)	16.9	(22)	$p > .5$
	16 - 31	15.3	(11)	17.3	(107)	$p < .01$
	total	15.6	(98)	17.2	(129)	$p < .01$
August		14.0	(22)	14.5	(9)	
September		13.5	(8)	----		
Nov. to Jan.		9.7	(10)	----		

(n) = number of suckles timed

TABLE 12 . Frequency of successful suckles and total number of seconds suckles by bighorn lambs per hour of female activity, 1969 and 1970.

	June				July			
	1 - 15		16 - 30		1 - 15		16 - 31	
	1969	1970	1969	1970	1969	1970	1969	1970
suckles/hr. ♀ 'up'	2.08	---	1.14	1.21	.94	.74	.93	1.24
seconds suck /hr. ♀ 'up'	41.93	---	23.72	26.78	15.27	12.60	14.07	21.87

	August				September	
	1 - 15		16 - 30		1 - 15	
	1969	1970	1969	1970	1969	1970
suckles/hr.	.53	.74	.49	--	.34	--
seconds suck	8.92	10.98	5.68	--	4.54	--

TABLE 13 . Calculated total seconds suckled by bighorn lambs per 24 hours, 1969 and 1970.

		seconds suckled/24 hrs.	
		1969	1970
June	1 - 15	513.2	---
	16 - 30	267.6	379.2
July	1 - 15	252.9	193.5
	16 - 31	141.8	267.7
August	1 - 15	100.6	181.8
	16 - 31	85.9	---
September	1- 15	63.2	---

TABLE 14 . Number of suckle attempts per hour of ewe Activity, Sheep River Area, 1969 and 1970

	1969	1970
June	1.44	1.82
July	1.58	1.98
August	1.14	1.61
September	.67	----

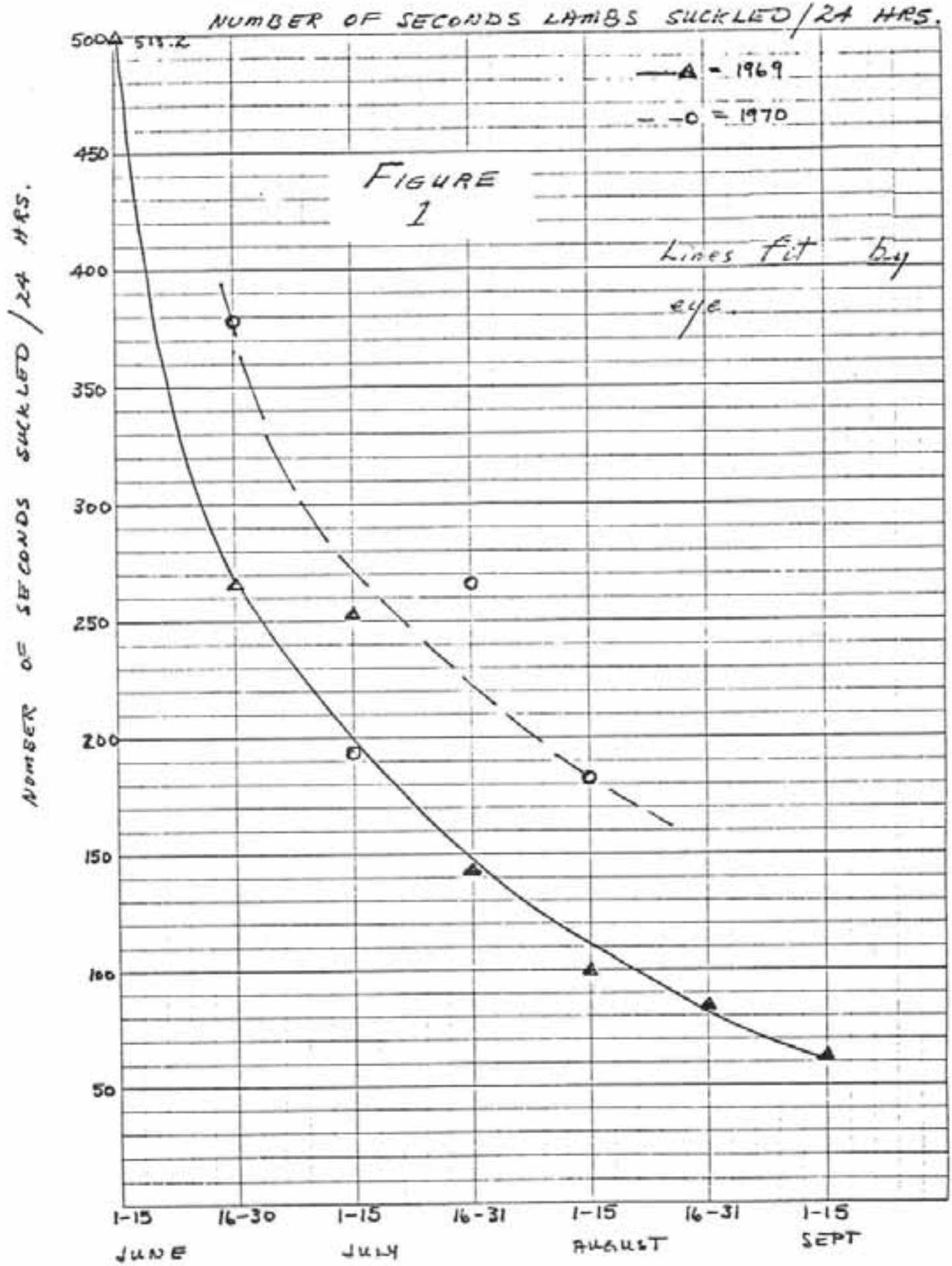
NUMBER OF SECONDS LAMBS SUCKLED / 24 HRS.
NUMBER OF SECONDS SUCKLED / 24 HRS.
500
450
400
350
300
250
200
150
100
50
513.2
—Δ— 1969
- -o- - 1970
FIGURE 1
Lines fit by eye.
1-15 JUNE
16-30
1-15 JULY
16-31
1-15 AUGUST
16-31
1-15 SEPT

TABLE 15 . Frequency of rejection of suckle attempts, bighorn lambs, 1969 and 1970.

		1969 (n)	1970 (n)
June	1 - 15	34 (201)	--
	16 -30	30 (82)	42 (147)
	total	33 (283)	42 (147)
July	1 - 15	39 (174)	30 (33)
	16 -31	55 (33)	51 (136)
	total	41 (207)	47 (169)
August	1 - 15	58 (33)	54 (26)
	16 -31	53 (51)	--
	total	55 (84)	--
September		50 (16)	--
November		79 (24)	--
December		37 (8)	--

(n) = number of suckles attempted

TABLE 16 . Frequency of 'approaches' used by lambs in successful suckling interactions, 1969 & 1970.

		1969			1970		
		SI(%)	RR(%)	(n)	SI	RR	(n)
June	1 - 15	81	19	(113)	--	--	
	16 -30	80	20	(50)	73	27	(161)
	total	81	19	(163)	73	27	(161)
July	1 - 15	84	16	(96)	64	36	(22)
	16 -31	67	33	(15)	66	34	(107)
	total	82	18	(111)	66	34	(129)
August	1 - 15	58	42	(12)	45	55	(9)
	16 -31	50	50	(24)	--	--	
	total	53	47	(36)	45	55	(9)
September	1-15	37	63	(8)	--	--	

SI = 'step-in' approach ; RR = 'run-around' approach
(n)= total number of approaches

FIG. 2 FREQUENCY OF CONTACT AND NON-CONTACT SUCKLING TERMINATIONS

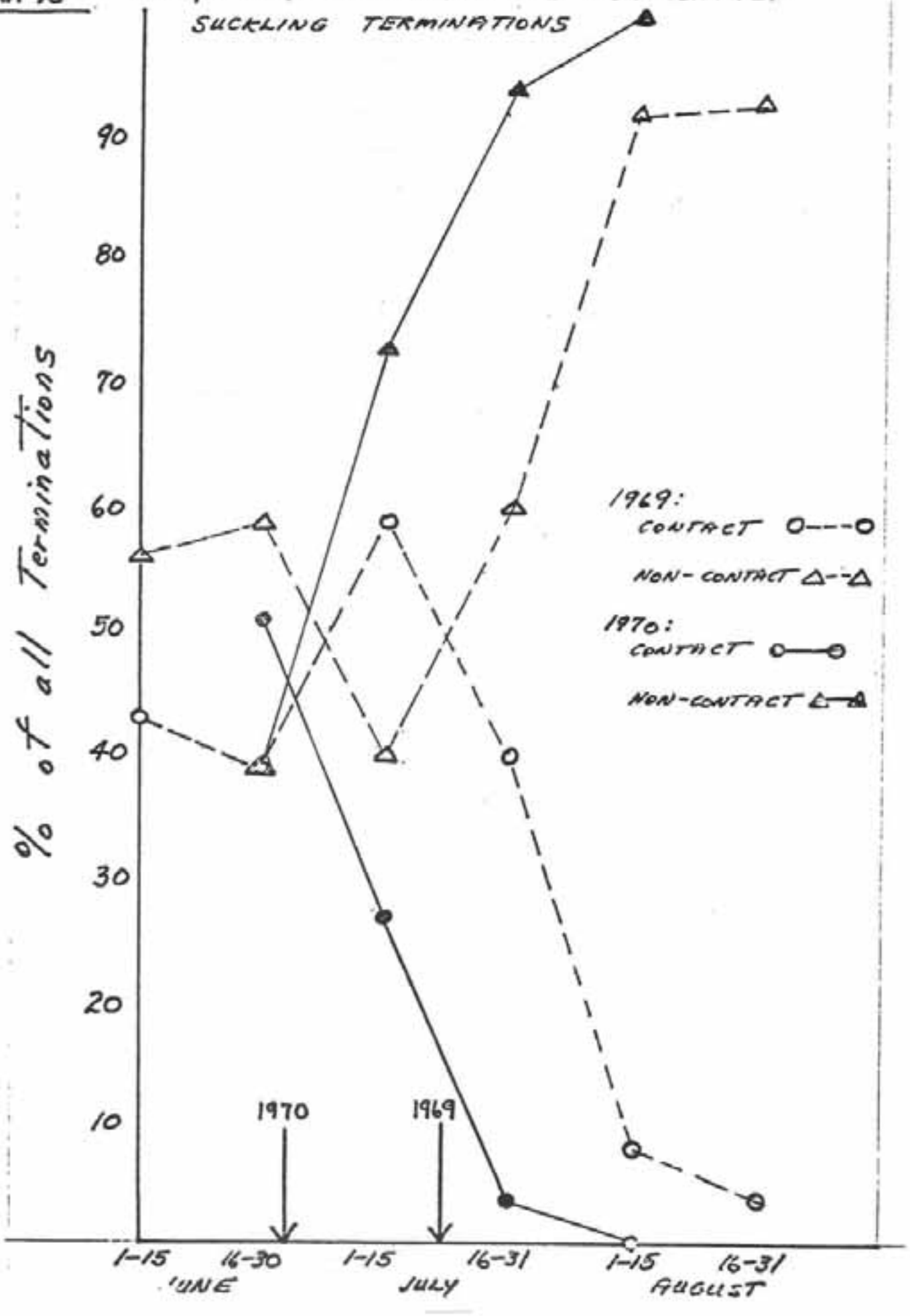

FIG. 3. APPROACHES USED IN SUCCESSFUL SUCKLES