# MOUNTAIN GOAT SOCIAL BEHAVIOR:

# SOCIAL STRUCTURE AND "PLAY"

# BEHAVIOR AS AFFECTED BY DOMINANCE

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Abstract: A small population of mountain goats in southwestern British Columbia has been studied to determine the factors affecting social structure. The study has revealed that the population is undergoing a drastic decline, and that the loss of younger age class goats is altering the types of behavior seen in social interactions; particularly aggressive and play behaviors.

Most of the social interactions that take place among members of the herd appear to be aggressive in nature. In many situations when there are twenty or more goats in one group, aggressive behaviors are seen every 15 or 20 seconds. The analysis of hundreds of these interactions reveals that males tend to dominate females, and that older goats usually dominate younger goats. One of the behaviors observed, referred to as "whirling", involves animals leaping into the air and twisting their bodies through one or more turns before landing. This behavior is practiced by goats of all ages, and is usually performed on steep snow slopes, apparently as part of play. I suggest that the situations which elicit this behavior indicate that in some circumstances, at least, it is motivated by aggression as well as a tendency to play. Considering the relative rarity of "normal play" behavior in the goats that I have studied, this possible connection between aggressive behavior and rare, but stereotyped, forms of "play" behavior is of particular interest.

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One of the most important problems in the study of behavior is the elucidation of the function of play behavior. Play has been claimed to contain elements of sexual behavior, aggressive behavior, and curiosity (as well as many other motivations), but so far both its evolutionary and individual significances remain speculative. There is, however, general agreement that play behavior is extremely important to the development of most mammals and that play assumes a more and more important role as one ascends the evolutionary scale (Wilson 1975, Aldis 1975). The effects of social deprivation early in the life of a variety of mammals lends further credence to the idea that early behavioral interactions, whether play or other behaviors, are cirtical to the normal development of the individual. The fact that play cannot be easily or precisely defined should not, then, hinder the study of activities which most investigators would agree are a vital part of the animal's behavioral development and would generally be called "play" even without a precise definition.

The present study is part of a long-term investigation of the social behavior of the mountain goat (Oreamnos americanus). This work was started in 1965 and has been carried out by observing goats for a limited period of time each year during the spring, summer, and fall months. My objective has not been to investigate intensively a particular herd of goats or the goats living in a particular area, but rather to record the behaviors and demographics of a small population over a relatively long period of time. As the general study has progressed, I have concentrated my attention on the following aspects of mountain goat sociobiology: aggression, communication signals, daily activity patterns, feeding, herd division and cohesion, injuries, leadership, mother-young relationships, play, predation, the goats' reaction to me, travel, and a peculiar aggressive-play behavior I cal "whirling". I have also observed closely an changes which might be induced by man's increasing utilization of the study area and the surrounding mountain ranges.

This paper concerns one of the aspects of mountain goat behavior that I have studied most intensively: the interaction between "play" behavior and aggressive behavior. Of course, play in most animals has strong elements of aggressive behavior, so it is entirely expected and predictable that the same would be true of these goats. What is unexpected is the extreme amount of aggressive behavior directed at younger, and therefore relatively defenseless, members of the group, and the relative rarity of what would normally be considered play behavior. The "pure" aggressive behaviors are rather predictable in their outcome, since older animals are usually dominant over younger ones, and males are usually dominant over females. One behavior called "whirling" violates these predictions, however, apparently because it is controlled by a combination of play and aggressive motivations and may in some instances be performed as an almost pure aggressive behavior and in other instances be performed as an almost pure play behavior. Such close associations between

aggressive and play motivations are probably common to most mammals (Wilson 1975, Hinde 1966), but the use of a "play" movement in an aggressive encounter may not be.

Although play behavior has not been studied nearly as extensively as many other behaviors detailed studies of play in many primates and other mammals are fairly common (see, for example, Wilson 1975). The play of ungulates has been thoroughly described by, among others, Darling (1937), Geist (1971), Muller-Schwarze (1968), Walther (1964), and Welles and Welles (1961). In all of these studies there is a clear connection between the movements used in fighting and those used in play. For example, Geist finds mounting and butting behavior as the most common elements of play in mountain sheep (Ovis canadensis), but sees many behaviors involving twisting, leaping jumps, which seem at least superficially similar to mountain goat behavior. Unfortunately, a lack of quantitative data on play makes it almost impossible to compare Geist's findings with mine, although there seems little doubt that elements of mountain sheep and mountain goat play are analogous.

## DESCRIPTION OF THE STUDY AREA

The study area (Fig. 1) is a relatively isolated plateau and associated mountains in southwestern British Columbia, approximately 48km north of Mt. Waddington, in the Coast Range. As can be seen in the figure, there are steep, high cliffs on the southeast, southwest, and northwest sides of the area, while a relatively gentle slope goes down to the northeast. Calwell Creek to the southwest and the Kleena Kleene River to the northwest hinder travel in those directions. The Kleena Kleene River is a large, swift and usually deep river, which is difficult to cross, while Calwell Creek is smaller, but still very swift and also difficult to cross. Goats almost certainly travel easily to the southeast, crossing a series of swamps and small streams to reach Perkins Peak and other mountains beyond it. The gentle, heavily timbered slope to the northeast provides easy access to the area for most large animals, but is presumbaly avoided by the goats.

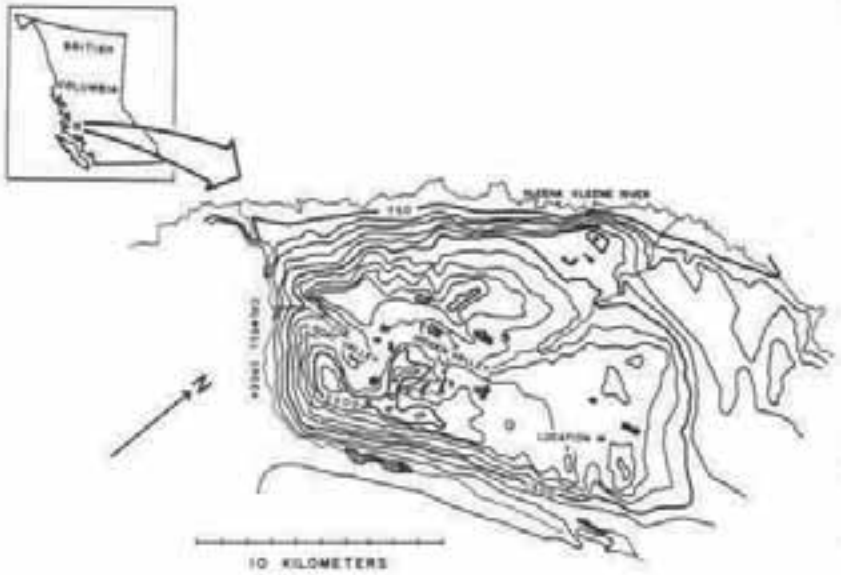


Figure 1. Contour maps of the study area. Elevations are in meters.

The high plateau and mountains making up the study area are approximately 16km long and six and a half km wide. Between location M and the mountains to the southwest is a flat, barren plateau five kilometers long and three kilometers wide. Another broad, flat area is found at the upper, northwest end of Hidden Valley, and on a small plateau on the northern edge of Goat Valley. All of these flat areas are heavily utilized by the goats during at least part of the summer months. They also, however, spend a remarkable amount of time in the heavy timber at the lower end of Goat Valley, and in the draws going down to the southeast of location M. The mountains on the southern and northern parts of the area are between 2300 and 2500m high and are generally bare rock or snow. Although the goats travel over these mountains, they spend little time on them except during unusually hot summer days, when insects are prevalent. Most of the time the bases of the mountains are utilized as bedding areas, but usually the chosen bedding sites are only 90 - 225m above the valley floors.

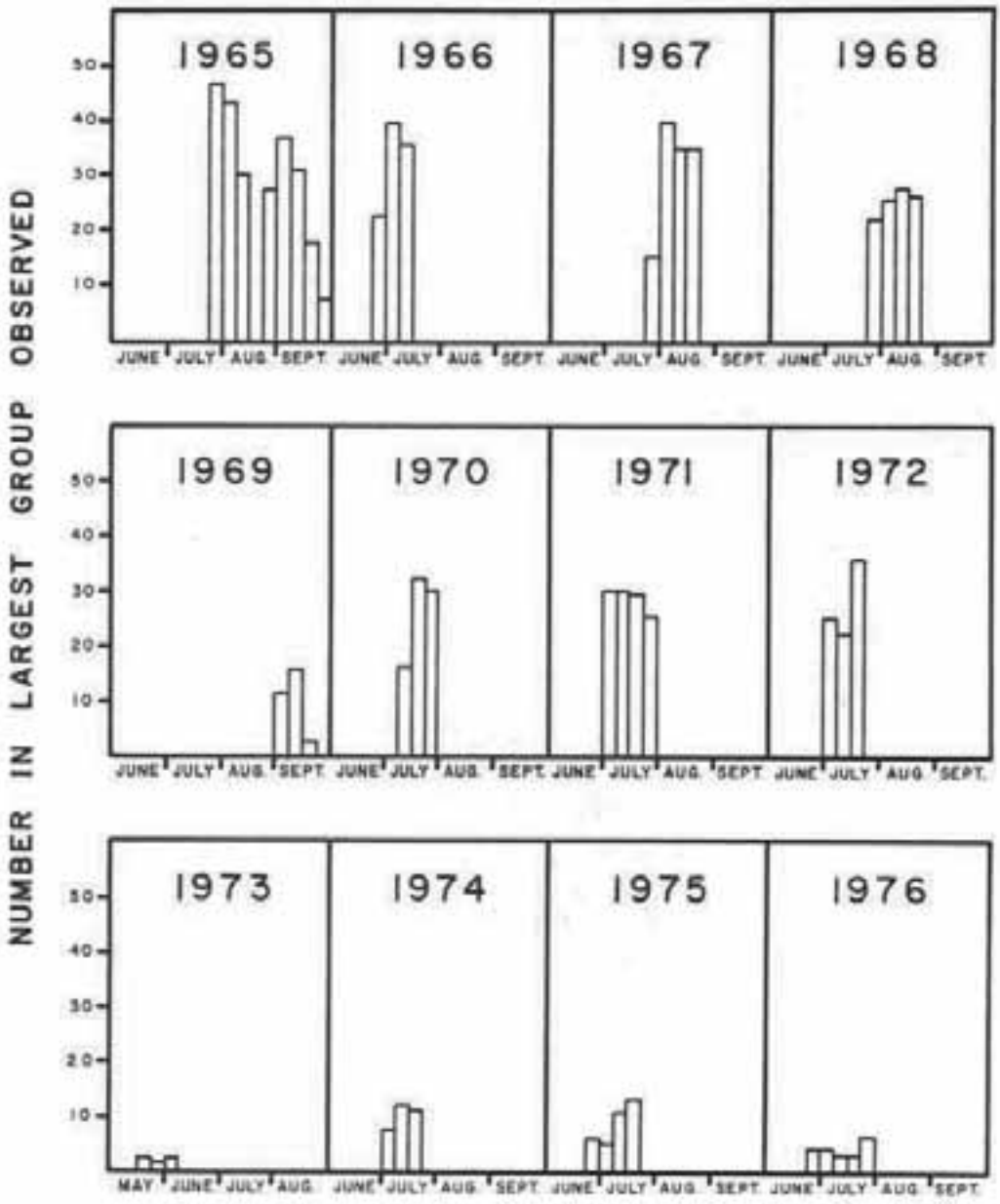


Figure 2. Largest group of goats observed during each week of the study.

## MATERIALS AND METHODS

Observations were made with either an 8 x 30 binocular or a 30 x 60 telescope. Although in many cases the animals showed little fear even when 5 - 10m away, I tried to stay at least 100m away in most situations. Notes were tape recorded to allow continuous observation of the animals, and in virtually all cases were transcribed that evening.

Table 1 lists the times of observation over a 12 year period, including the total number of hours during each field season. These figures include only the amount of time when I was directly observing the goats with either a telescope or binocular. Approximately 800 additional hours were spent close to goats, but not directly observing them. These data can be summarized as follows: 214 days in the field; 642.6 hours of direct observation. Particularly in 1969 and 1973, I tried to go to the area both early and late in the year to obtain information on the sociobiology of the herd. Data from these two years indicate that in general the goats leave the area in the middle of September and return during June, depending on the severity of the weather and the depth of the snow.

Table 1. Periods during which goats were observed from 1965 - 1976.

| Year | Date | Hours Observed |
|---|---|---|
| 1965 | July 29 - August 9, August 28 - Sept. 4<br>Sept. 10 - Sept. 18, Sept. 27 & 28 | 67.5 |
| 1966 | June 28 - July 10 | 37.8 |
| 1967 | August 6 - 16, August 20 - 23 | 49.5 |
| 1968 | August 1 - 12, August 16 - 21 | 50.3 |
| 1969 | September 5 - 21 | 28.4 |
| 1970 | July 16 - 30 | 41.8 |
| 1971 | July 14 - 24, July 31 - August 6 | 68.3 |
| 1972 | July 1 - 12, July 16 - 21 | 62.5 |
| 1973 | May 18 - June 7 | 37.8 |
| 1974 | July 2 - 18 | 68.7 |
| 1975 | June 26 - July 9, July 14 - 30 | 69.1 |
| 1976 | July 8 - 26 | 60.9 |

Between 1965 and 1974, 15,000 feet of 16mm motion picture film was taken. This was done to produce accurate records of behavioral sequences which would later allow careful analysis of changes in behavior over time and possibly accurate identification of individuals from their horn structure and general physical appearance. A disastrous fire in April, 1975, destroyed all of the film and all of the data which had been analyzed. The original field notes were preserved, allowing a reanalysis of the written material.

## RESULTS

Before discussing specific aspects of play or aggressive behavior, it is necessary to discuss the way in which the herd has changed over time. Even the most superficial examination of the data indicates a drastic decline in the size of the main herd and of the numbers of goats inhabiting the study area. Since the size of the group has a marked influence on the amount of aggressive behavior and on the opportunities for play and other social activities, a clear picture of any reduction in the number of animals must be presented before trying to explain the relationships between different social activities. Therefore, the sections that follow will discuss changes in herd size, the way in which goat societies are structured, an analysis of play behavior as seen in young individuals, and an analysis of "whirling" behavior, an apparently aggressive-play behavior.

Herd Size - The data presented in Table 2 indicate the numbers of goats in the study area each year. Where possible, the figures are broken down into the goats of different age classes. Much of the data on herd composition was lost (fire), thus details of herd composition can no longer be made for 1965, 1966, and 1967. I have also indicated the number of adult males in the study area, although this figure is certainly not exact. Adult males frequently spend their time together with other adult males, or alone, but relatively infrequently are they a part of the main herd. Since all available time was spent observing the main herd, I did not systematically search out these isolated goats. Probably the numbers given for adult males is correct in relative terms, and many air searches indicate that the total numbers of adult males is approximately correct.

Table 2. Number of goats in each age class in each year.

| Year | Age Class* 0.3 | 1.3 | 2.3 | Adult Female | Adult Male | Total |
|---|---|---|---|---|---|---|
| 1965 | 10 | ---------- 34 ---------- | | | 3 | 47 |
| 1966 | 3 | 10 | ---------- 25 ---------- | | 2 | 40 |
| 1967 | 11 | 2 | ---------- 28 ---------- | | 1 | 42 |
| 1968 | 3 | 6 | 2 | 23 | 2 | 36 |
| 1969 | 3 | - | 2 | 11 | 2 | 18 |
| 1970 | 7 | 4 | 2 | 20 | 3 | 36 |
| 1971 | 7 | 6 | 3 | 14 | 2 | 32 |
| 1972 | 8 | 5 | 5 | 16 | 3 | 37 |
| 1973 | 0 | 1 | - | 2 | 1 | 4 |
| 1974 | 0 | 4 | 2 | 10 | 1 | 17 |
| 1975 | 2 | 0 | 1 | 10 | 1 | 14 |
| 1976 | 0 | 1 | 2 | 4 | 1 | 8 |

* The approximate age of the goats during the months when most of the study was conducted (July, August, September ).

There has been a decline in the goat population, but the decline has been irregular. The first year of the study, 1965, saw the highest population, with a slight decline over the next two years. Remembering that in 1969 I was in the study area late in the fall, making the numbers for that year difficult to assess, it seems that the population was relatively static from 1968 to 1972. Again, 1973 is a difficult year to assess, because I was there very early in the spring. However, 1974, 1975, and 1976 show a dramatic decline in the goats, when observations were made largely during July, a time of high population in other years. These same data are seen in more graphic form in Fig. 2, which shows the largest groups of goats seen in each time period that I was in the area. In order to simplify the comparison of each year's data, I have lumped the data together into blocks, each block representing approximately one quarter of a month. The blocks are from the first to the seventh day, the eighth to the fifteenth day, the sixteenth to the twenty-second day, and the twenty-third day to the end of the month. Again, a dramatic decline in the population is seen, although it must be remembered that here the figures are not representing the total number of goats in the study area, but rather the maximum size of any grouping observed.

If the data for 1969 and 1973 are once again considered inconclusive, the other years show an initially gradual and then very sharp decline in the number of young goats - kids and yearlings. Since the females keep their young with them for at least two years, they mate only every other year. During the first four years of the study, there was a sharp imbalance in the number of young produced each year, apparently due to this staggered breeding. The data for 1970, 1971, and 1972, however, show a consistent number of kids, while the data for 1974, 1975, and 1976 show almost no kids.

These data also indicate that the same group of goats visit the area each year. Neglecting 1969 and 1973 the numbers of kids, yearlings, and two-year-olds are consistent from year to year, in most years of the study. Inconsistencies are seen in later years probably indicating that only part of the herd was observed each year. Animals not observed either failed to migrate to the study area or did not arrive during my field season.

When it became apparent that the herd was decreasing in size, I felt reasonably sure that the reason for the decline was the drastic change in the weather seen in the Kleena Kleene area and throughout the northern hemisphere (Kukla and Kukla 1974). Reconnaissance both by air and snowmobile (Roger Dane pers. comm., Allan Bittner pers. comm.) indicate that no goats spend the winter months in the study area. Most apparently migrate approximately 25km southeast, although some evidence indicates that there may have been a shift in the migratory pattern so that more animals may now move southwest. Since the goats definitely leave the area during the winter, I felt that heavy summer snow and cold weather might prevent their return. Certainly my weather records show unusually deep snow in 1972, 1973, 1974, and 1976, with a gradual increase in the size of the snow banks in the study area. Particularly in 1974 and 1976, the snow was deep until the end of July. (In contrast to the cold, late years, 1975 was a dry year, with little snow in the mountains, and the temperatures recorded at my base camp were the highest that I have seen in 12 years.) This shift to generally cold, late years, with heavy snow, may be responsible for the herd decline, but there are no weather stations near the study area, and my records are kept for such short periods each year that their data are not conclusive.

Social Structure - When mountain goats are together in a group, there is a surprisingly large amount of aggressive behavior. Since they appear to use a comparatively small repertory of communication signals, I propose that these frequent aggressive encounters are one of the most important elements in establishing the structure of the group. Furthermore, aggressive behavior has clear connections with play behavior, which strengthens the view that aggression is important in shaping the relationship between individuals.

During the twelve years of this study, I have tried to record large numbers of aggressive, or seemingly aggressive, interactions to find out how predictable the outcome of such encounters may be. Although 774 encounters have been analyzed, data on many more encounters were lost (fire). Nonetheless, the remaining data do show certain trends in these social interactions (Fig. 3). Actions used by dominant individuals are grouped into four categories, although in some cases (13 out of 774) actions in two categories were used during a single interaction. The division of aggressive behavior into four categories is, of course, subjective, but is based on the following assumptions. Movements involving moving toward another individual at a walk, slight motions of the head toward another individual, or circling around another individual at a walking pace have all been included in the category "Head Movement or Circle" (abbreviated H.M. or C. in Fig. 3). All of these behaviors are "low intensity" in that they involve interactions of short duration and relatively slight amplitude (Hinde 1970). The next category, "Hook" (abbreviated H.) is also variable, but inevitably involves the aggressor hooking its horns toward the individual to be displaced. In violent hooks the fron feet of the animal may lift off the ground and the body may twist through up to 180 degrees. Chases have been rather arbitrarily divided into two categories usually on the basis of the length of chase. "Chase" (abbreviated Ch.) refers to chases of usually less than 10m and a duration of less than 5 seconds. "Extreme Chases" (abbreviated E. Ch.) often last for 15 - 20 seconds, sometimes as much as 300 seconds, and routinely cover 20 or more meters.

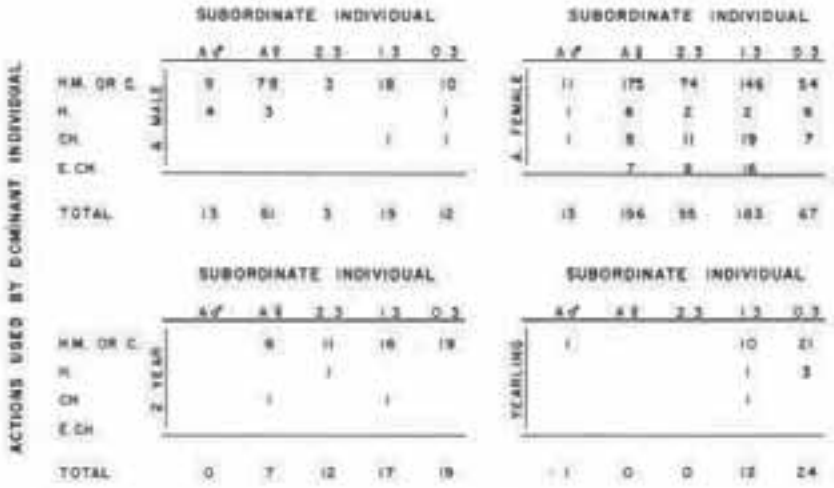


Figure 3. Analysis of aggressive encounters (A♂ = adult male, A♀ = adult female, 2.3 = two-year-old, 1.3 = yearling, 0.3 = kid; H.M. = head movement, C. = circling, H. = hook, Ch. = chase, E. Ch. = extreme chase).

The data in Fig. 3 show that out of 774 interactions, males were the aggressors in 132 instances (17 percent), females in 561 instances (72 percent), two-year-olds (sex not specified) in 44 instances (6 percent), and yearlings in 37 instances (5 percent). Male aggression further shows virtually no chasing behavior and a preponderance of interactions involving males displacing adult females. Female aggressive interactions are almsot equally directed at adult females and yearlings, while two-year-olds and kids are less commonly attacked. Two-year-olds and yearlings are not particularly aggressive, but usually follow the rule of attacking only animals in the same or a younger age class.

However, the analysis of male/female interactions is not as clearcut as it appears. As Geist (pers. comm.) has correctly observed, the fact that a goat withdraws after an encounter does not necessarily mean that that goat is submissive; it may withdraw even if it is dominant. Apparently, in these situations, the withdrawal is based on a motivation to avoid conflict, rather than to participate. Furthermore, young males (two-year-olds) are often more aggressive than adult males, and therefore may disobey the normal conventions of being subordinate to older individuals. My data show some of this ambivalence when females are dominant over males, and when two-year-old males are dominant over adult (four years or older) males. Part of this difficulty has been overcome by eliminating any encounter from consideration where I was unsure of the outcome, but decisions on this point are not absolute, and should not be viewed as such. It is also important to state that unlike Geist's goat herds (Geist 1964), my herds frequently contain adult males, who may remain with the herd for days at a time, and are clearly very dominant over all females.

Play Behavior - There is still no satisfactory definition of play behavior. Inevitably, each investigator must make decisions about which activities will be classed as play, as opposed to purely exploratory, agonistic, etc., behavior. These decisions are partially based on subjective criteria. This has been as much of a problem with mountain goats as with any animal, because play is so intimately associated with aggressive behavior. The definition used by Bekoff (1972): "social play is that behavior which is performed during social interactions in which there is a decrease in social distance between the interactants, and no evidence of social investigation or of agonistic (offensive or defensive) or passive-submissive behaviors on the part of the members of a dyad (triad, etc.) although these actions may occur as derived acts during play", is appealing in its simplicity, but may well eliminate most activities from being categorized as play. There is no way that I can deduce the underlying motivation when a young mountain goat goes through a behavior which appears to me to be play. What I have done instead is to establish 10 categories of activity which appear not to be either purely exploratory or purely aggressive, but which often involve a decrease in social distance. These actions have usually been performed in social situations, but are sometimes performed by single animals. In cases where there was doubt in my mind about whether a behavior should be classed as play as compared with aggression or exploration, I have deleted the data from further consideration. Such apparently confusing behaviors have been seen rarely.

The 10 movements seen regularly in play behavior are: Butting, Circling, Head Over, Head Under, Hooking, Jumping, King of the Castle, Mounting, Running Away, and Whirling. Before discussing the parameters of play, I will describe each of these actions. Beside the name of the action are figures showing the number of times each action has been seen and its approximate duration. The number of times each behavior has been observed is very low for two reasons. First, many of the data were destroyed by the fire. Aggressive and play behaviors were the focus of much of the film, and were recorded with the obvious intention of later detailed analysis. Second, the longest and most intense play bouts seen were very early in the morning, when the light was poor and the goats were about 2km away. At that distance in the dim light prior to sunrise, many behaviors were recorded only in general terms, and not in detail.

Butting: observed 75 times, duration 2-5 sec. This action involves one individual lowering its head and butting another individual. When accompanied by "circling", the butts are usually directed at the side or rump of the other goat, since the two goats are in a head-to-tail orientation. At other time, butting may be directed at any part of the other goat, although about 70 percent of the time the rear part of the body is chosen. Many times butts are given repeatedly.

Circling: observed 80 times, duration 5-25 sec. As already stated, circling occurs in a head-to-tail orientation with the sides of the two goats anywhere from a few centimeters to a meter apart. The few data available for analysis indicate that there is an almost even division in the direction of circling behavior and indicate that the direction of circling alternates quite regularly. A typical play sequence shows circling clockwise for two full turns, counterclockwise for one turn, clockwise for two turns, clockwise for one and one half turns, counterclockwise for two turns, and clockwise for one turn. Circling may be rapid of slow, depending on the intensity of play.

Head Over: observed 20 times, duration 2-20 sec. This is a variable behavior as one goat may put its head over almost any part of the other goat. In 9 instances, the head was put over the back, in 8 instances over the rump, and in 3 over the neck. Head Over may precede Mounting.

Head Under: observed 8 times, duration 5-40 sec. Like Head Over, this action is variable. In 6 instances, the head was put under the belly, in one instance between the hind legs, and in one instance under the neck. Head Under was accompanied by butting in 6 cases. The action is very forceful and on three occasions the body of the goat receiving the action was lifted partially off the ground. Once, the butting activity seemed to cause pain, and the kid being butted repeatedly sat down on its haunches, apparently trying to the individual with its head under to stop the behavior.

Hooking: observed 4 times, duration 2-5 sec. Hooking in young goats looks like that seen in adults, with one animal usually hooking at the side or rump of the other. The action is so rare in the bouts of play analyzed that little can be said about it.

Jumping: observed 88 times, duration 2-3 sec. When two or more young goats are on a rock or a mound of earth, one will often leap off the elevation, usually with a highly exaggerated jump. I define exaggerated as a jump that carries the animal far from the start of the jump and often in a long "sailing" arc. Such behavior has been seen in other situations, particularly when young goats are crossing streams. The most intense performance of jumping that I have observed was part of a game of "King of the Castle", in which each of the participants alternately jumped off a series of large rocks.

King of the Castle: observed 13 times, duration 10 sec. to 3 min. This is a form of the classical game wherein one animal ascends a projection and tries to keep others from gaining a position at the top. Although seen rarely, some of the games were long, involving up to 13 different scalings of the rock by the two participants. As will be seen, this complex game is interspersed with Butting, Circling, Jumping, Head Over, Head Under, Running Away, and Whirling.

Mounting: observed 93 times, duration 3-45 sec. In all cases, the goats mounted each other from either the side or the rear, with rear mounts being much the most common. Sometimes pelvic thrusting was seen, though rarely, and when thrusting was seen, the mounts tended to last for at least 10 seconds. When one goat succeeded in mounting another, it usually, but not always, put one front foot on each side of the other individual.

Running Away: observed 64 times, duration 3-10 sec. One goat runs away from another, which may be followed by the other one chasing it. Obviously a highly variable behavior.

Whirling: observed 25 times, duration 1-4 sec. In a sense, the most interesting of all play behaviors, because it is performed by adults as well as young individuals and sometimes by single goats. The action varies in its intensity. In a low intensity whirl, the goat tosses its head while partially twisting its body and usually raises its forefeet off the substrate. At greater intensities, the head toss becomes extreme, lifting the body into a vertical position until the hind legs leave the ground. The twisting motion that accompanies the initial head toss is continued so that the animal may make at least one complete turn, in the air, before landing. During play bouts, Whirling is less common than Jumping or Running Away, but is frequently associated with these activities.

What I classify as play behavior has been seen rather rarely among members of the group. Out of 214 days in the field, I observed goats on 191 days and saw some form of play behavior on 37 days. On those 37 days, 89 "bouts" of play were observed. A bout as defined here means any continuous sequence of play behavior, with the realization that under field conditions precise marking of the end of a bout is difficult. Usually such problems do not arise, since play bouts tend to be very short and occur at widely scattered times of the day. There are no instances where I feel that two bouts have been separated where they were actually one bout, but in the few instances where the goats played for long periods of time (10 minutes or more), there is some likelihood that the play periods were made up of more than one bout. If play stopped for more than 30 seconds, the resumption of play was classified as a new bout.

The data on the frequency of play are biased to some degree by the almost total absence of young goats in the group in 1969, 1973, 1974, 1975, and 1976. No play was seen in 1973 and 1976, one bout in 1969, two bouts in 1974, and two bouts in 1975. This bias can be eliminated by considering only data obtained during 1965-1968 and 1970-1972. Doing so shows that out of 114 days when goats were observed, play was seen on 32 days and 84 bouts were recorded. Of these 84 bouts, durations were recorded in 77 cases, revealing an average duration of 261 seconds with a standard error of 66 seconds. The very large standard error is explained by the fact that 38 bouts had a duration of 20 seconds or less, while there were 7 bouts that lasted from 10 minutes to 52 minutes. Out of a total play period of 5 hours 40 minutes recorded in 1965-1968 and 1970-1972, 3 hours 20 minutes were consumed by 7 long play periods, the specifics of which are as follows:

| Time of Day | Duration | Group Composition |
|---|---|---|
| 4:50 - 5:34 a.m. | 44 min. | 2 kids |
| 5:00 - 5:52 a.m. | 52 min. | 4 kids |
| 9:46 - 10:05 a.m. | 19 min. | 3 kids |
| 1:44 - 1:55 p.m. | 11 min. | 2 kids |
| 2:03 - 2:22 p.m. | 19 min. | 2 kids |
| 3:50 - 4:40 p.m. | 40 min. | 2 kids |
| 10:15 - 10:30 p.m. | 15 min. | 2 kids |

Further analysis of the data indicates the frequency with which play was seen each day and is shown below.

| No. of bouts/day | No. of days when seen |
|---|---|
| 1 | 11 |
| 2 | 9 |
| 3 | 1 |
| 4 | 2 |
| 5 | 5 |
| 6 | 4 |

Usually, then, only one or two bouts of play were seen on any given day, but on 11 days 4 or more bouts were observed (Table 3). There does not seem to be a particular pattern to these data, except that all of the days when play was common were either in July or August (the months when I was usually in the study area, and when the goats reach their peak number in the study area) and the bouts of play tend to occur during the middle of the day.

Table 3. Days on which four or more bouts of play were seen.

| Date | Time of Play Periods | No. of Bouts Observed |
|---|---|---|
| July 9, 1966 | 11:20 - 3:20 | 5 |
| August 16, 1967 | 11:30 - 3:30 | 5 |
| August 21, 1968 | 10:40 - 12:00 | 6 |
| July 18, 1970 | 11:10 - 9:00 | 5 |
| July 19, 1970 | 9:45 - 10:50 | 6 |
| July 21, 1971 | 10:30 - 7:30 | 4 |
| July 23, 1971 | 1:30 - 3:00 | 4 |
| August 4, 1971 | 12:00 - 2:50 | 5 |
| July 3, 1972 | 1:25 - 3:15 | 6 |
| July 4, 1972 | 1:30 - 2:15 | 5 |
| July 18, 1972 | 3:00 - 4:45 | 6 |

Most bouts of play occur when two kids are playing: 67 percent of all bouts seen. Bouts containing three and four kids are fairly common, (16 percent and 5 percent respectively) but all other groupings, including instances where yearlings played with kdis, are rare. In three cases there were two yearlings who played together without kids.

Two other major aspects of play were observed in detail: the reaction of other individuals in the group to those playing, and the number of times when two or more kids were together without play occurring. Other individuals reacted to play on 13 occasions. Seven times adults in the group, not related to any of the playing participants, came toward the playing group and forced all members of the group to move away. Out of these seven instances, there were three times when the kids were playing on top of a rock and the adult made them jump down, once when an adult ran after two playing kids, and three times when the adult simply walked toward the kids. On two occasions, mother's kid, and on two other occasions a mother came toward playing kids and forced the kid, or two kids, not belonging to her, to move away. Once a yearling and once a two year old also forced two playing kids to move away from the rock on which they were playing.

There were 30 times when two or more kids were within two meters of each other for two minutes or more and failed to show any play. On one occasion, six kids were "together" for 40 minutes without playing. The data on the behaviors used to initiate play were contained on the film, so it is impossible to tell whether eliciting signals were never given or whether the other member(s) of the group failed to respond to such signals.

Whirling Behavior - Whirling has been described previously in this paper as a play movement, so I will not describe it again. It is important, however, to reiterate that this jumping, twisting behavior is highly variable both in form and in duration. A low intensity (small movement, short duration) Whirl consists of nothing more than a toss of the head which partially raises the forward part of the body, while in a high intensity (large movement, long duration) Whirl, a goat will jump several feet in the air and twist around through more than 360 degrees.

The first question to be investigated with Whirling was the size of the group when some members of the group Whirled. Whirling was most common in large and small groups and rare in medium-sized groups (Table 4) ($x^2 = 14.1$, $p = 0.05$). Whirling occurred on any terrain, although 63 percent of the 61 bouts occurred on steep slopes (Table 5). When Whirling did occur on steep slopes, the benefit to the animal was considerable, since about 20 percent of the time when Whirling was intense, the animal slipped as it landed. While it may be more likely to slip when landing on a steep slope, the likelihood of injury is far less. Although once again the sample is very small, the table shows that 75 percent of the time Whirling which was part of play occurred on steep slopes. (Note that although goats whirled 25 times while playing, this occurred in 8 bouts).

Table 4. Size of the group when at least one goat whirled.

| Group size: | 0-4 | 5-9 | 10-14 | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 |
|---|---|---|---|---|---|---|---|---|
| # instances: | 11 | 8 | 8 | 2 | 2 | 8 | 13 | 9 |

Table 5. Conditions under which Whirling took place.
(The general behavioral categories of Whirling are shown in the left column, while the types of terrain on which it took place are shown horizontally.)

| | General Terrain Features | | | | |
|---|---|---|---|---|---|
| | Steep Snow | Flat Snow | Steep Earth or Rock | Flat Earth or Rock | Total |
| Aggressive | 10 | 2 | 2 | 7 | 21 |
| Non-aggressive | 16 | 2 | 6 | 10 | 34 |
| Play | 3 | 2 | 3 | | 8 |
| Total | 29 | 6 | 11 | 17 | 63 |

Whirling was considered to be aggressive when one individual approached another and directed the Whirl at that other goat. When animals perform this action, they may do so in direct contradiction of the expected dominance hierarchy; that is, a younger animal may direct the action at an older animal and still not suffer the consequences that would ensue if the younger individual attacked the older one in a more definatively aggressive fashion. Usually the movement of the head which started the Whirl was toward the other goat, but in some situations one would approach another and whirl when one or two meters away. This behavior seemed to be part of a "greeting ceremony" which is seen when one individual approaches one or more other individuals after being separated from them for apparently long periods of time (unpub.). The decision that such a behavior is directed at another goat is not subjective, since in all cases aggressive Whirling was accompanied by other aggressive behaviors, particularly Head Movements and Circling. Since much aggressive Whirling behavior involves only one goat Whirling, I further investigated all instances involving a single individual Whirling (Table 6). This was done to determine whether all instances involving single goats Whirling were aggressive in nature, or whether goats Whirl singly as a play movement. These interactions show that kids and yearlings usually whirl alone when no aggression is involved, while two-year-olds and adults often whirl alone when aggression is involved. (Particularly in the kids and yearlings these Whirling bouts may involve more than one Whirl.) It is somewhat surprising to see that adults whirl alone almost as often without aggression as with agression, and leads me to believe that even in adults, Whirling is often a type of play behavior. Although the data on kids may appear to violate the principle stated earlier that young individuals may only be aggressive to animals of the same or a younger age class, the two times when kids whirled "aggressively" were actually times when the kids had just been displaced by adults. The kids, then, were apparently whirling in response to adult aggression. Most of the time, however,

kids and yearlings whirled singly either as part of play bouts, or in situations which were probably motivated by play and not by aggression.

Table 6. Analysis of Whirling when only one goat Whirled.
(The general behavioral categories of Whirling are shown in the left column, while the age classes of the goats are shown horizontally.)

| | Age Class of Whirling Individual (in years) | | | | |
|---|---|---|---|---|---|
| | 0.3 | 1.3 | 2.3 | Adult | Total |
| Aggressive | 2 | 3 | 5 | 5 | 15 |
| Non-aggressive | 9 | 5 | 1 | 4 | 19 |
| Play | 2 | 2 | | | 4 |
| Total | 13 | 10 | 6 | 9 | 38 |

The final aspect of Whirling to be investigated is the identity of individuals who whirl when most, or at least a large percentage, of the group whirls. Without the film, only four cases could be analyzed where five or more individuals participated in a Whirling bout. Apparently adults participate as much as young goats in these mass Whirling bouts. While it is true that the adults do participate in Whirling, the kids and yearlings usually whirl many times per Whirling bout, while the adult females often whirl only once. In terms of total Whirls per bout, then, the young age class goats (kids and yearlings) are far more active than older individuals.

## DISCUSSION

The preceding data on mountain goat social behavior and demographics indicate that the group under study has undergone a severe population decline during the past three years, and a gradual decline during the preceding nine years. Reasons for the decline may well rest on changing weather patterns, but several other possibilities should be mentioned; namely predation and man's increased utilization of the area. My data on predation are sketchy, at best, but indicate an essentially stable population of predators. Figures are based on actual sightings of predators and on measurements of tracks. These show that except in 1970-1972, there have been between one and three wolves that periodically visit the area, a family of grizzly bears in 1965 and 1967, but otherwise only single grizzlies passing through at infrequent intervals, and usually no black bears except in 1965, when there were five families, and two single individuals. (In 1970, 1971, and 1972 no wolves were known to have visited the study area). Mountain lions have never been seen, and tracks have been observed on only two different years. In 1967, the family of grizzlies killed an adult goat, (sex unknown) and in 1974 I watched two wolves attack three goats: two adults and one two-year-old. My data, then, do not indicate that at least in this study, predators have caused the population decline, but data are sparse.

Man's presence may have had greater effect. Unfortunately, in 1969, a dirt road was constructed to Perkins Peak, the next mountain to the south of the study area. This greatly facilitated transport into the general area and multiplied enormously the number of people affecting the goats. Limited data suggest that much of the group migrated over Perkins Peak up to 1969, while in later years goats seemed to enter the area from the southwest. Again, these data are very poor and can serve only as a suggestion, but it may be that the road and its concommitant increase in numbers of people has contributed to the herd's decline. Of interest, in this regard, is the density of the other two ungulates who inhabit the study area: moose (Alces alces) and mule deer (Odocoileus hemionus). During the course of the mountain goat study I have kept records of all sightings of these two species. The data are inconclusive, but indicate a substantial decrease in the deer population while the moose population has apparently remained stable. Whether the apparent decrease in the number of mule deer is correlated with weather changes remains unknown.

Clearly the dramatic decline in the mountain goat population has greatly affected all parts of the study. The almost total absence of young age class goats during the period 1973-1976 has been so drastic that few instances of play or Whirling have been seen. During 1977 I plan to visit the area in August, the month of greatest density in other years, to make certain that the goats are not simply arriving in the area later than they used to. Such a possibility seems relatively unlikely, since the population was so small in 1975 when the snow cover had largely melted by July 1st.

The analysis of aggressive behavior, although greatly reduced by the lack of film and the reduction of herd size in recent years does show some significant trends. As was found by Hibbs et al. (1969), adult females were usually the aggressors. Most of their aggressive interactions were of the type described by Geist as weapon-threat or present-threat (Geist 1964), and often involved only walking toward another individual or slightly lowering the head at another individual. It is also apparent from the data in Fig. 3 that females are rarely dominant over males, but that when males exhibit dominance it is usually toward an adult female. Geist (1964) found that females were dominant over males, but does not give enough data to make a comparison with this study viable. Possibly since his study was conducted late in the fall, during the rutting period, there had been a change in dominance status. I have never observed my herd in October and November, so I have no idea whether they might change the clear male dominance seen during the spring and summer months. Since females are the aggressors 72 percent of the time, it may make sense that they are virtually the only individuals who perform either "chase" or "extreme chase" actions, but the result seems surprising to me. I had expected to see male Chases as well as female Chases, but the actual situation only reinforces the view that in this herd, at least, females are the really aggressive individuals. The exact relationships between known individuals and between different classes of adult females (females with kids, females with yearlings, and females without young) are being analyzed (unpub.).

Geist (1964, 1966, 1967) emphasized properly the danger involved in the primitive type of aggressive encounters engaged in by mountain goats. In the present study, fur was dislodged in 4 of 29 instances of Hooking. Although none of these actions appeared to injure the recipient, the possibility of severe injury was clearly present. During the 12 years of the study, 18 injured goats were seen. Three of the injured individuals were kids and all appeared to have been hurt by horn punctures; all apparently recovered. There were also four injured two or three-year-old individuals who seemed to have been hurt in aggressive encounters. The other 11 goats were older individuals and in only three cases was it reasonably certain that the injury was inflicted by another goat. Such evidence adds at least some credence to the idea that fighting in goats is often overt aggression rather than a series of displays.

Since aggression plays such an important role in the formation and maintenance of mountain goat societies, one would almost predict the presence of a movement like Whirling. This action is almost certainly controlled by a variety of motivations. It has been seen in isolated single individuals, where it is difficult to imagine that aggression is important, and in groups where it either preceded, alternated with, or followed more clearly aggressive behavior, such as Hooking and Chasing. The action seems at least superficially like leaping seen by Muller-Schwarze in black-tailed deer (Odocoileus hemionus columbianus) (Muller-Schwarze 1968), the threat jump in bighorn sheep (Ovis canadensis) (Geist 1971), cavorting in the wildebeest (Connochaetes taurinus) (Estes 1969), the jumping, turning, twisting movements seen in various cavimorphs: the degu (Octodon degus), the chor-chor (Octodontomys gliroides), the salt desert cavy (Dolichotis salinicola), and the harbor seal (Phoca vitulina) (Wilson and Kleiman 1974), and possibly like stotting, as exemplified by Grant's and Thompson's gazelles (Gazella granti and G. thompsonii) (Estes 1967). Like many of these actions, seen in a variety of different species, Whirling often seemed to be "pure" play behavior: that is, there were no connecting aggressive actions. Its use as an aggressive behavior, however, is also reasonably clear. The fact that single adults, single two-year-olds, and single yearlings will approach another goat, perform Head Movements or Circling, as well as possibly Hooking and Chasing, and then Whirling leads me to think that in those situations the Whirl is largely aggressive.

The question then becomes, why Whirl instead of performing some other more usual aggressive behavior? I believe that the answer lies in the interpretation that other animals give to a Whirl. If it is most often used as a play behavior, or at least as a non-aggressive behavior (Tables 5 - 7) then the animal performing such an action during an aggressive encounter may indicate an ambivalence in its behavior. The kids and yearlings in Table 6 who whirled aggressively could not have circled an adult or two-year-old without being immediately attacked. The same may apply to older goats; a subordinate two-year-old or adult apparently can whirl at a dominant without fear or retribution.

Little has been said about the mass Whirling bouts shown in Table 7. Although details have been lost (fire), it is clear that in these bouts of Whirling, most of the Whirls are performed in undirected fashion, and that considering all of the Whirls that have been seen in 12 years, most are performed in large groups when many goats Whirled. Most of the time, the Whirls are given under circumstances where the goats are separated from one another by distances of 8-10m. The two largest Whirling bouts for which data were not stored on film both took place on July 21, 1971. In the first one, occurring at 12:06 p.m., the group of 22 individuals had just unbedded and was coming down a steep (25 degrees) snow slope. All of the goats whirled, although as usual, the kids and yearlings tended to whirl multiple times, while the adults tended to whirl only once. In most cases a goat would run down the slope, leap into the air whirling, and stop after landing. The behavior was intermittent, each goat whirling as it neared the bottom of the slope. Usually at any given moment only one goat was whirling. At 1:30 p.m. the goats crossed another snow slope, in this case the slope being only about 10 degrees, and again intermittently whirled as they ran down the last section of the slope. As before, each goat was well separated from other members of the group, and

each appeared to wait until no other goats were whirling before it whirled. There was some overlap in the Whirling, but remarkably little considering the density of the group (here, 20 instead of 22 individuals). Such behavior is difficult to construe as aggressive in nature, seeming more like "contagious" play behavior. Small bouts of Whirling were apparently seen by Lentfer (1955), but the descriptions do not provide more than an indication of what was happening. Mass Whirling bouts may be analogous to bighorn sheep huddles (Geist 1971).

If such behaviors are play, they are apparently rather different from what has been recorded in other ungulates. Geist (1971) notes that adult bighorn sheep play "rarely", but that when they do, the play tends to occur early in the day, just after the sheep have unbedded. This may be an interesting parallel with goat behavior, since the longest kid play bouts were seen at first light. Whirling was also observed very early in the morning (4:40 - 5:00 a.m.) which effectively ruled out the possibility (which I had earlier considered) that Whirling was a response to heavy concentrations of insects. When seen early in the day, the temperature at base camp varied from -5 - 2 degrees celsius, and was probably similar where the goats had spent the night. It is hard to imagine that under these conditions the animals were bothered by insects. Estes (1969) also saw adult wildebeests play rarely, but did see cavorting (similar to Whirling) frequently when adults ran away from a predator. In this case cavorting becomes a high intensity threat display.

Such connections between play behavior and aggression or threat are probably common (Aldis 1975). Aldis does not believe, however, that dominance relationships are established during play, but instead in more "serious" situations. My data are not complete enough to either support or oppose this conclusion.

Poole and Fish (1975) found that in rats 81 percent of all play actions were variations of adult behavior, 16 percent were purely playful, with no adult equivalence, and 3 percent were like adult behaviors. Most of the adult behaviors or variations of adult behaviors were aggressive in nature. In mountain goats, Circling and Hooking appear to be like adult behaviors (20 percent), Butting, Head Over, Head Under, Jumping, Running Away, Mounting, and Whirling seem to be variants of adult behavior (70 percent), while King of the Castle seems unique to play (10 percent). This last category is perhaps misleading since King of the Castle (seen also by Darling 1937, in red deer) is really a complex of many behaviors, combined into one game. The game is unique to kids and yearlings, but the elements making up the game are variants on adult behavior or seem not to change as the animal develops.

In most situations, mountain goat play can be carried out among two or more members of the same age class, even if one is much larger, and apparently stronger, than the other. Similar situations have been recorded in polecats (Poole 1966) and, as already mentioned, in bighorn sheep (Geist 1971). In these situations where individuals of different size are playing, the larger individual could presumably overpower the smaller individual and thus act in a rather pure aggressive fashion as opposed to playing. As already noted, various play actions may be performed by yearlings and kids together, but such play is rare, and it is difficult to tell whether the yearling is motivated primarily by aggression or play.

Whatever the motivation for play, it was seen on only 30 percent of the days when the goats were observed, and occurred during only 2 percent of the observation time. These figures are for the group as a whole, and would be much lower for any individual animal. Such figures seem low when compared to other species, but most of the data are from primates and so may not be at all comparable. Aldis (1975) specualtes that "advanced species" may play for approximately 30 - 60 minutes per day, but this figure is for each individual. The possibility remains that the goats play more frequently than the data indicate, because they may play commonly very early in the day when they are usually not seen. There have been two occasions when I did watch them very early in the day (4:30 - 5:00 a.m.), when there were either 7 or 8 kids present and no play occurred. These data are not helpful in establishing whether play normally occurs before sunrise. The observations were made primarily before the time when the two long play bouts (observed on two other days) started. Goats may, then, play more often than the data indicate. There is an indication, though, that play is often not a strong motivation, since there were 30 occasions when kids were within a few meters of one another for two or more minutes, and no play occurred. Normally the kids are scattered throughout the group, remaining relatively close to their mothers. Whatever factors drew them together were apparently not motivated primarily by play.

One aspect of play which has not been considered is the role of sex. Aldis (1975) believes that mounting is not part of play and that it normally disrupts the smooth flow of play behavior. Interruptions in play as brief as one second which occur during the transition form other actions to mounting, he considers as constituting such a disruption. Without analyzing film, I cannot begin to interpret such short intervals of time, but do feel that mounting behavior is part of the normal play sequence. The following excerpt is from my notes of July 18, 1972, and shows an apparently smooth transition from other play actions to Mounting. (Part of the sequence has already been included in the analysis of circling behavior)

3:54 - Butting, then one pushes the other off the rock. Back up. Circle left. Neck over back, pushing other down off rock. Back up. Pushes one on top onto rump, almost pushes off. Circle clockwise two turns. Neck over back - pushes down. Now other does same thing, so are alternating pushing each other down. Neck over back, forefoot and shoulders pushing. Pushes one down who did pushing last time. Comes back up. Circl counter-clockwise one turn. Mounting. Butting. One pushed down. Back up. Mounted. One who is mounting almost gets pushed off. Circle clockwise two turns. One pushed down, gets pushed down again as tries to climb back up. While at bottom jumps up at other. Then goes around to other side of rock and again jumps at other on hind legs. Back up. Is mounted. One who mounted is pushed off. Circle clockwise one and one half turns. One pushed down. Back up. Circle clockwise two turns. Mounting. Butting. One in awkward position, other has head between hind legs and is lifting off rock. Does not quite fall. Circle clockwise one turn. One huge jump off rock landing at least 10 feet from base. Then back up.

Such data are not very quantitative or exact, but lead me to feel that Mounting is part of the play routine.

The most complex play movement seen is certainly Whirling. Furthermore, it is probably the dominant play action seen in adults. Such "rotational" actions may be preactice for emergency manoeuvers (Aldis 1975), or they may be practice for aggressive interactions. I rather like Bekoff's statement that complex play behaviors may be performed because they are "pleasurable" (Bekoff 1976). Whatever its motivation, Whirling is a fascinating variable activity, which remains enigmatic.

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