

Mating and Incidental Activities of Ram (*Ovis aries*) When Exposed to Ewe(s) and Competitor Ram in Pen Mating Condition

M. Patel*, N. Das, H. N. Pandey, M. C. Yadav¹ and P. S. Girish²

Division of Livestock Production and Management, Indian Veterinary Research Institute (IVRI)
Izatnagar, Uttar Pradesh (UP), 243 122, India

ABSTRACT : An attempt was made to analyze the factors affecting mating performance of rams in pen mating systems. Due to many types of social interactions, mating performance of rams may decrease or increase. Six intact Muzaffarnagari rams were used and divided into three dominant subordinate pairs by food and ewe competition test. For dominant rams subordinate ram became competitor and vice versa. In the first experiment, ram was exposed to ewe but the competitor ram was kept outside the pen with the facility of visibility only. In the second experiment each ram was exposed to ewe along with the competitor ram and in third experiment ram was exposed to ewes (two) along with competitor ram in observation pen. Recordings of different mating and agonistic behaviour were done in all the experiments. It was found that subordinate ram's mating behaviour was inhibited by mere presence of a dominant ram out side without physical contact. However, when ram exposed to oestrus ewe(s) along with competitor ram, both dominant and subordinate rams spent much of their time in guarding activities instead of mating. In addition dominant ram tried to curtail the subordinate ram mating by agonistic interaction like fight and butting. Different guarding activities were observed either as active or passive type depending on level of dominance. It was concluded that in a limited space the interaction of two or more rams might affect the number of services adversely. (*Asian-Aust. J. Anim. Sci.* 2005. Vol 18, No. 4 : 463-469)

Key Words : Ram, Behaviour, Dominant, Guarding, Audience, Ewe

INTRODUCTION

Generally one ram for 30-40 ewes is kept for mating in the flock with the assumption that each ewe in the flock will get equal opportunity to be mated during the limited breeding season. It is always advised for minimum number of selected males for impregnating the females in a relatively short period of time. Selected males should have good libido; any variations in libido can have quite considerable consequences in farm economics (Nawaz et al., 1998). Ram sexual behaviour mainly under controlled flock conditions had been studied by several workers. There are many types of social interactions (reciprocal interaction of two or more animals and the resulting modification of individual activity), which may decrease or increase the mating performance of ram. Young rams usually show low libido for introduction to a new group (Holmes, 1980). It is possible that mere presence of a dominant sheep can inhibit mating behaviour of subordinates even without physical contact (Lindsay et al., 1976). It has been seen that situation where space is limited, a dominant ram could suppress the

mating performance of a subordinate. The suppressing of male performance by another dominant male watching from a nearby pen is a real phenomenon and termed as audience effect. Where as some other workers have found that mating performance of rams working under open pasture conditions was not affected by dominance when number of services per day was recorded. Mattner et al. (1974) found that sexual activity was greater in multiple rather than in single bull groups as indicated both by number of services and number of mounts.

Keeping the above facts in mind an attempt was made to study the ram behavior and ram performance under different social conditions. And study was made to determine the effects of dominance among rams on mating behaviour in pen mate condition. The results of this study will be useful in predicting the relative contribution of various rams when mated in groups as is often done in range and pasture breeding also whether mating in groups has any beneficial effect.

MATERIALS AND METHODS

This study was conducted in sheep and goat farm of Indian Veterinary Research Institute (IVRI) with the aim to analyze the factors, which affect mating behaviour of ram in pen mating system. Six intact, healthy and sexually experienced Muzaffarnagari rams of age 2 and 3 years were selected for the study. Rams and ewes used in this study were maintained under standard feeding and managerial conditions. Eight healthy, sexually matured ewes of similar

* Corresponding Author: M. Patel. Department of LPM, G.B. Pant University of Agriculture and Technology, Pantnagar, District: US Nagar, Uttaranchal State, 263 145, India. Fax: +91-05944-233473, E-mail: girishlpt@yahoo.com

¹ Division of Gynaecology and Obstetrics, IVRI, Izatnagar, UP, 243 122, India.

² Division of Livestock Products Technology, IVRI, Izatnagar, UP, 243 122, India.

Received May 10, 2004; Accepted November 13, 2004

age and body weight were ovariectomized and artificially brought in to oestrus every 6th day by using the protocol of Kilgour and Whale (1980). On the first and third day, 25 mg of progesterone (Proluton Depot, German remedies) and on fifth day, 200 to 250 µg of oestrogen (Oestrogen, mac. Millon) were administered by deep intramuscular route. Ewes were observed for oestrus using teaser ram. Although the six ewes were given the same hormone treatment some ewes showed little oestrus response while others showed intense oestrus, which necessitated the standardization of the dose of oestrogen for each ewe.

All experiments were conducted in the observation pen having the area of 4 m×3 m. Recording of mating behaviour of ram commenced immediately after the introduction of ewe(s) in to the pen or vice versa. The observations were made every ten seconds for ongoing mating activities like sniffing, vocalization, leg kicking, vocalization with leg kicking, nudging with head, flehmen reaction, urination by ram, false mounting, mounting and ejaculation. The mating activities were recorded for 60 min mating session.

Frequency and mean intensity of each mating activities were calculated as follows:

$$\text{Frequency (\%)} = \frac{\text{No. of mating sessions in which activity were exhibited}}{\text{Total number of mating sessions}} \times 100$$

$$\text{Mean intensity} = \frac{\text{Total number of occurrence of the activity}}{\text{Number of mating sessions in which activity exhibited}}$$

Assessment for compatible dominant-subordinate pairs

Pilot experiment was conducted for making compatible dominant-subordinate ram pairs, which are prerequisite for further experiments. For this experiment six experimental rams were divided into three pairs randomly. Those three pairs were assessed for the compatibility by both food competition and ewe competition tests.

Food competition test : Each pair of rams was fasted for 15-17 h prior to the start of food competition session. This time interval was chosen as being long enough to result in sufficient motivation to compete for food while not causing unnecessary stress to the animal involved (Erhard et al., 1998).

A bucket of feed was fixed in the corner of the pen, mouth of the bucket tapers towards bottom, so that the two animals can enter their head but only one can have access to food. Before the testing, animals were allowed to familiarize to eat from the bucket. On the test day both the rams were put together into the food pen. The time spent on eating by each ram was noted using stop clock. The clock started when the animal put its head into the food bucket and started eating, and the clock stopped when the animal left the bucket (stepped away), either voluntarily or when forced away by the opposing ram. Occasionally ram lifted

its head to chew the food and the time spent in the act was counted as eating time. The ram that completed 5 min eating (either in single or multiple bouts) was declared dominant over the other. Same test was repeated 5 times on alternate day.

Ewe competition test : Each pair of rams was allowed to interact with single oestrus ewe. The ram, which mated first, was considered as dominant to other. The test was repeated 5 times on separate days to find out the consistency of the relationship. Ewe was restrained to minimize the ewe activity during testing.

Experiment 1

Mating behaviour of ram exposed to oestrus ewe and audience ram : Two rams viz., mating and audience ram were used in the experiment. The ram, which allowed mating with oestrus ewe in the mating pen, was described as mating ram. The ram which viewed the mating activity from outside the mating pen was called audience ram. Changes in mating activity due to audience ram were the audience effect. In this experiment, audience pen and mating pen was separated by open metal barrier which permitted unrestricted visual, auditory and olfactory contact without allowing audience rams to interfere physically with mating ram.

Three pairs of rams, which were assessed by food and ewe competition test used for this experiment. On the first day; all the mating activities were recorded for each of the 3 subordinate rams with oestrus ewe but when viewed by respective dominant ram from audience pen as audience ram. On second day, an identical experiment was conducted for the dominant rams with the subordinate being used as audience ram. Experiment was repeated 3 times for each of the experimental rams.

Number of mounts and ejaculation for subordinate and dominant rams during 1 h mating session were averaged and compared with mounts per hour, ejaculation per hour for subordinate and dominant rams in absence of audience ram. (Patel et al., 2004, in press)

Experiment 2

Mating behaviour of ram exposed to one oestrus ewe and one competitor ram : On the day of experiment each pair of rams with known dominant-subordinate relationship was exposed to single oestrus ewe in the observation pen. The occurrence of sniffing, vocalization, leg kicking, mounting, and ejaculation of both the dominant and subordinate ram were recorded during 60 min session.

However, the following agonistic activities of ram viz., incidences of i) butting ii) fighting and iii) time spent in different types of guarding were also recorded.

- Butting : A dominant animal directs an attack against the neck, shoulder, flank or rump of a subordinate

Table 1. Frequency (%) of mating activities in rams exposed to single oestrus ewe and audience ram

Mating activities	Ejaculations during one hour				
	First ejaculation	Second ejaculation	Third ejaculation	Fourth ejaculation	Fifth ejaculation
Sniffing	-	33.33 (2.66)	33.33 (1.66)	50.00 (2.66)	55.55 (1.80)
Vocalization	33.33 (1.33)	55.55 (4.50)	66.66 (4.33)	61.11 (5.00)	88.88 (4.75)
Leg kicking	16.66 (1.00)	50.00 (2.77)	55.55 (2.40)	61.11 (2.54)	66.66 (5.00)
Leg kicking with vocalization	11.11 (1.00)	77.77 (3.78)	61.11 (5.36)	77.77 (3.57)	66.66 (4.00)
Flehman	-	5.55 (1.00)	5.55 (2.00)	5.55 (1.00)	-
Urination	-	5.55 (1.00)	11.00 (1.25)	5.55 (1.00)	11.00 (1.00)
Nudging with head	-	-	-	-	-
False mounting	-	11.11 (1.00)	-	-	11.00 (1.00)
Mounting	38.88 (1.16)	33.33 (1.00)	38.88 (1.57)	27.77 (1.40)	24.44 (2.00)

Figures in parentheses indicate the mean intensity.

who in turn submits and avoids the aggressor.

- **Fight :** The rams push against each other head to head.
- **Guarding :** In 2 rams and single ewe situation, the usual standing pattern of rams was that, both rams always stood on one side of the ewe (ewe did not stand between two rams). Each ram preferred to be in the middle position i.e. between oestrus ewe and other ram. The ram in the middle position (described as defender ram) always tries to defend its position by frustrating the attempts of other ram i.e. challenger ram.

It is quite possible that challenger ram may become defender and vice-versa. This guarding process is the most predominant activity in this experiment. While guarding the ewe the defender ram may be either stationary or moving with ewe. The mode of defending may be either active or passive. In active guarding, defending ram will guard the ewe by making leg kick bouts, vocalization and some times by butting. In passive guarding both defender ram and challenger ram will stand still. Depending on the movement, position (in relation to ewe) and mode of guarding exhibited by defender ram, the guarding process was divided into four types as follows,

- Guard 1 : Standing beside ewe, active guarding
- Guard 2 : Standing away from ewe, active guarding
- Guard 3 : Standing beside ewe, passive guarding
- Guard 4 : Standing away from ewe, passive guarding

For each pair the experiment was repeated 3 times.

Experiment 3

Mating behaviour of ram exposed to two oestrus ewes

and one competitor ram : The same dominant-subordinate pairs used in experiment 1 and 2 were utilized in the present study. All the mating activities like sniffing, vocalization, leg kicking, flehman, mounting, ejaculation of both dominant-subordinate rams were recorded during 60 min observation. Incidences of non-mating activity like fight; butting and time spent in different types of guarding (as mentioned in experiment 2) were also recorded.

However, in 2 rams and 2 ewes condition besides earlier mentioned guarding activities a new type of guarding was found where 2 rams will be standing together actively (G5) or passively (G6) and each ewe will be on either side of rams.

RESULTS AND DISCUSSION

Experiment 1

Mating activities in rams exposed to single oestrus ewe and audience ram : Frequency (%) and mean intensity of different mating activities in rams exposed to single oestrus ewe and audience ram are presented in Table 1. The result shows that frequency of courtship was low before first ejaculation and the intensity of teasing activities like leg kicking, vocalization, leg kicking with vocalization values increased with subsequent ejaculation. Flehman, urination and false mounting were not very common activities and the frequency varied from 0 to 11%. Nudging was absent before each ejaculation. Frequency of mounting ranged from 24 to 39% and intensity ranged from 1.0 to 2.0. There are no references to compare the above data.

i) Audience effect on mating behaviour of rams : Number of mounts per hour was 12.98 ± 9.58 , 2.16 ± 0.95 , 6.0 ± 3.02 and 4.58 ± 2.87 for dominant ram under audience

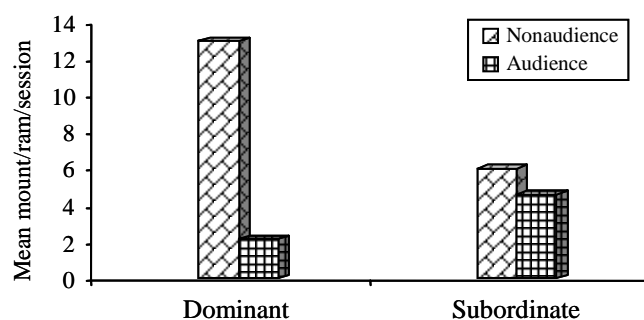


Figure 1. The mean number of mounts per session for dominant and subordinate rams in non-audience and audience conditions.

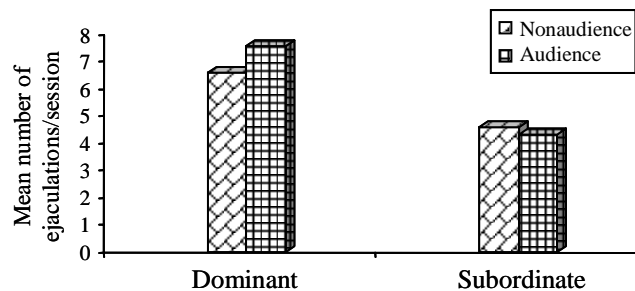


Figure 2. The mean number of ejaculations per session for dominant and subordinate rams in nonaudience and audience conditions.

Table 2. Frequency (%) of mating activities in rams exposed to competitor ram and single oestrus ewe

Mating activities	Ejaculations during one hour							
	First ejaculation		Second ejaculation		Third ejaculation		Fourth ejaculation	
	One ewe	Two ewe	One ewe	Two ewe	One ewe	Two ewe	One ewe	Two ewe
Sniffing	5.55 (1.00)	-	16.66 (2.00)	5.55 (1.00)	11.11 (2.00)	5.55 (1.00)	-	-
Vocalization	33.33 (1.50)	11.11 (1.50)	11.11 (1.75)	11.11 (2.00)	11.11 (2.50)	11.11 (1.00)	-	5.55 (1.00)
Leg kicking	- (4.00)	5.55 (4.00)	11.11 (3.00)	16.66 (5.66)	16.66 (3.33)	11.11 (4.5)	5.55 (3.00)	-
Leg kicking with vocalization	33.33 (2.33)	11.11 (1.00)	22.22 (6.00)	11.11 (1.5)	16.66 (6.60)	5.55 (1.0)	11.11 (4.50)	11.11 (1.00)
Flehman	16.66 (1.00)	5.55 (1.50)	16.66 (2.00)	11.11 (1.00)	11.11 (1.00)	-	-	-
False mounting	-	11.11 (1.5)	-	-	-	-	-	-
Mounting	33.33 (4.83)	16.66 (2.00)	16.66 (3.00)	22.22 (1.50)	11.11 (3.00)	11.11 (4.00)	5.55 (2.00)	-

Figures in parentheses indicate the mean intensity.

effect, dominant without audience effect, subordinate ram under audience effect and subordinate ram without audience effect (Patel et al., 2004, in press) respectively. Number of ejaculations per hour for the corresponding rams were 6.58 ± 1.90 , 7.55 ± 2.90 , 4.58 ± 1.00 and 4.32 ± 0.42 , respectively.

Audience effect reduced the mounts/h in both dominant and subordinate by 6.0 and 1.3 times respectively (Figure 1). But no such trend was observed for ejaculation/h. Under audience effect number of ejaculations per hour increased slightly in case of dominant ram, whereas, it decreased marginally in subordinate rams (Figure 2). Lindsay (1976) and Kilgour and Winfield (1974) also reports that dominant ram can inhibit mating behaviour of subordinates without social contact.

Experiment 2

Mating activities of rams exposed to oestrus ewe along with competitor : Table 2 represents frequency (%) and mean intensity of mating activities in rams exposed to single oestrus ewe and one competitor ram. When two rams were used (dominant-subordinate pairs), both rams were engaged in guarding activity instead of mating activities.

All the mating activities before first, second, third and fourth ejaculations were observed in less than 1/5th of the total mating session except leg kicking with vocalization and mounting before first ejaculation, which were observed around 1/3rd of the total mating sessions. Mainly dominant rams exhibited courtship activities. False mounting was absent before first, second, third and fourth ejaculation. In closely confined group of ewes, the dominant ram performs a large majority of the services and may prevent other rams from mating ewe leading less courtship activity (Hafez, 1975).

i) Non-mating activities in rams exposed to oestrus ewe and competitor : Non mating activities viz. guarding, fighting, butting and urination shown by three dominant and subordinate ram pairs in presence of single oestrus ewes are shown in Table 3. Time spent in different types of guarding depends on the level of dominance. Dominant ram of first pair had high level of dominance over the subordinate and this was evident from the behaviour of subordinate ram, which always avoided conflict. Hence, dominant ram spent more time in passive type of guarding (i.e. 25.38 min in G3 and 10.66 min in G4) than active type of guarding (i.e. 7.49

Table 3. Mean \pm SD time spent (minutes) in different types of guarding and incidental activities by three dominant subordinate ram pairs when exposed to single oestrus ewe during one hour mating session

Guarding types	Pair I		Pair II		Pair III	
	Dominant	Subordinate	Dominant	Subordinate	Dominant	Subordinate
Standing beside ewe:active guarding (G1)	7.49 \pm 6.18 (3.00)	0.00	7.60 \pm 4.39 (3.00)	0.00	26.30 \pm 0.95 (3.00)	2.33 \pm 1.50 (2.00)
Standing away from ewe:active guarding (G2)	5.94 \pm 1.92 (3.00)	0.00	26.99 \pm 6.90 (3.00)	0.00	8.27 \pm 5.67 (3.00)	1.66 \pm 0.00 (1.00)
Standing beside ewe:passive guarding (G3)	25.38 \pm 11.65 (3.00)	0.00	7.54 \pm 2.79 (3.00)	0.00	16.49 \pm 5.21 (3.00)	0.00
Standing away from ewe:active guarding (G4)	10.66 \pm 6.66 (3.00)	0.00	9.54 \pm 4.47 (3.00)	0.00	4.91 \pm 0.41 (2.00)	0.00
Incidental activities						
Fight	2.00 \pm 0.00 (2.00)	0.00	1.00 \pm 0.00 (1.00)	0.00	4.00 \pm 3.00 (2.00)	2.00 \pm 0.000 (1.00)
Butting	1.50 \pm 0.50 (2.00)	0.00	15.66 \pm 4.44 (3.00)	0.00	4.50 \pm 3.50 (2.00)	1.00 \pm 0.00 (2.00)
Urination	3.00 \pm 0.00 (3.00)	4.66 \pm 2.05 (3.00)	1.50 \pm 0.50 (2.00)	2.00 \pm 0.00 (2.00)	1.50 \pm 0.50 (2.00)	4.33 \pm 2.62 (3.00)

Figures in parenthesis indicate mating session in which guarding types and incidental activities were found.

min in G1 and 5.94 in G2) respectively. Although dominant-subordinate relationship was clear in second pair but the subordinate was not totally subservient to dominant ram, as a result dominant ram had to spend more time on active type of guarding (7.54 in G3 and 9.54 min in G4) than passive type (7.6 in G1 and 26.99 min in G2).

In third pair social ranking was not distinct between dominant and subordinate. Therefore, dominant ram spent much time in active type of guarding (26.3 in G1, and 8.27 min in G2) than passive guarding (16.49 G3 min and 4.91 min G4) and subordinate also adapted G1 and G2 type of guarding and spent 2.33 and 1.66 min respectively. No reference is available to compare the findings.

Number of fight incidences, butting and urination for dominant rams were 2.00, 1.50 and 3.00 respectively for 1st pair, 1.00, 15.66 and 1.50 respectively for second pair and 4.00, 4.50 and 1.50 respectively for 3rd pair. Shreffler and Hohenboken (1974) found that agonistic behaviour with ram pairs was greater in two-ram combination than in three pair combination.

Only dominant rams of three pairs except subordinate of third pair did fight initiation and butting. Butting by dominant rams of second and third pair were more when compared to 1st pair. It may be because of less position gap in the ranking between the animals. This confirms the results of Schein and Fohrman (1954) working with dairy cows and Meese and Ewbank (1972) working with pigs who reported that agonistic interactions were more common between individuals of adjacent social rank than between individuals separated more widely in the hierarchy. Urination was found in all the subordinate and dominant animals, but mean urination values of the subordinate were high in comparison to the dominant ram, which might be due to frustration in their attempts to mount.

Experiment 3

Mating activities in rams exposed to multiple oestrus ewes along with competitor ram : Table 2, represents the frequency and mean intensity of mating activities in rams exposed to multiple oestrus ewes. As it can be seen from the table that none of the activities have been observed more than 22.22%. As it was noted frequently that a subordinate ram would repeatedly mount a receptive ewe though he was punished repeatedly by being butted away by a dominant competitor before copulation was achieved. It was also observed in study that dominant rams were frequently disturbed from mating activity by their own due to mating activity of competitors. This pattern was also observed in ram pairs with groups of oestrus ewe in a limited space by Shreffler and Hohenboken (1974), Hulet et al. (1962b), Marcowitz et al. (1966) and Lindsay (1966). Lindsay and Robinson (1961 a,b) and Mattner et al. (1967) found that mating performance of rams working under open pasture conditions was not affected by dominance when number of services per day was recorded. But Bourke (1967) in a limited trial with three rams only found that in a 7.5 ha field, the dominant rams marked more ewes than the two subordinates. Conversely, Mattner et al. (1971) concluded that the mating activity of young rams was not appreciably altered by the presence of another ram in the flock. However, such type of variation in ram performance could be due to ewe size (Kiyanzad et al 2003).

Non-mating activities in rams exposed to multiple oestrus ewes and competitor ram : Mean time spent (min) in different types of guarding and incidental activities by three dominant-subordinate ram pairs exposed to multiple oestrus ewes are presented in Table 4. In the first pair dominance was complete i.e. dominant ram exercised full authority over subordinate. Dominant ram guarded both the

Table 4. Mean \pm SD time spent (minutes) in different types of guarding and incidental activities by three dominant subordinate ram pairs when exposed to multiple oestrus ewe during one hour mating session

Guarding types	Pair I		Pair II		Pair III	
	Dominant	Subordinate	Dominant	Subordinate	Dominant	Subordinate
Standing beside ewe:active guarding (G1)	12.82 \pm 5.30 (3.00)	0.00	24.87 \pm 10.11 (3.00)	2.08 \pm 0.58 (2.00)	6.48 \pm 2.16 (2.00)	7.00 \pm 6.66 (3.00)
Standing away from ewe:active guarding (G2)	1.61 \pm 0.55 (3.00)	0.00	24.48 \pm 14.14 (3.00)	0.00	0.00	0.00
Standing beside ewe:passive guarding (G3)	33.99 \pm 2.50 (3.00)	0.00	2.88 \pm 1.37 (3.00)	0.00	0.00	0.00
Standing away from ewe:active guarding (G4)	7.32 \pm 0.66 (2.00)	0.00	2.55 \pm 0.00 (1.00)	0.00	0.00	0.00
Two rams standing together, active guarding and each ewe on either side of the rams (G5)	0.0	0.00	0.00	0.00	23.04 \pm 8.40 (3.00)	23.04 \pm 8.40 (3.00)
Two rams standing together, passive guarding and each ewe on either side of the rams (G6)	0.0	0.00	0.00	0.00	18.15 \pm 9.08 (3.00)	18.15 \pm 9.08 (3.00)
Incidental activities						
Fight	3.30 \pm 0.94 (3.00)	0.00	1.00 \pm 0.00 (1.00)	0.00	1.00 \pm 0.00 (2.00)	0.00
Butting	5.00 \pm 2.82 (3.00)	0.00	25.66 \pm 6.94 (3.00)	0.00	8.00 \pm 2.94 (3.00)	1.00 \pm 0.00 (1.00)
Urination	1.50 \pm 0.50 (2.00)	2.00 \pm 0 (3.00)	1.00 \pm 0.00 (2.00)	2.00 \pm 0.00 (1.00)	1.66 \pm 0.94 (3.00)	2.33 \pm 0.47 (3.00)

Figures in parenthesis indicate mating session in which guarding types and incidental activities were found.

ewes and did not allow the subordinate ram to mate. As the subordinate ram avoided conflict, dominant ram spent more time in passive type of guarding (i.e. 34 min in G3, and 7.32 min in G4) than active type of guarding (i.e. 12.82 in G1 and 1.61 min in G2).

In the second dominant-subordinate pair dominance was not complete. Dominant ram was unable to mate the oestrus ewe although it guarded both ewes during most of the experimental time. Here, dominant ram spent more time on active type of guarding (i.e. 24.87 min in G1 and 24.48 min in G2) than passive type of guarding (2.88 min in G3 and 2.55 min in G4).

In the third pair, the level of dominance was low, which was evident from the fact that both the rams guarded one ewe each by adopting either G5 or G6 types of guarding (where two rams stood jointly between two ewes). Both the rams spent same time in G5 guarding (23.04 min) and G6 guarding (18.15 min). For a short duration (< 7 min) both dominant and subordinate ram guarded both the ewes using G1 type of guarding.

Agonistic interactions like fight and butting by dominant ram were 3.30 and 5.00 respectively for 1st pair, 1.00 and 25.66 respectively for 2nd pairs and 1.00 and 8.00 respectively for 3rd pair. As it can be seen from table, butting was more in 2nd and 3rd pairs, may be because of less social ranking difference. This confirms the result of Schein and Fohrman (1954), Shreffler and Hohenboken (1974) and Meese and Ewbank (1972). Urination was found to be more in subordinate when compared to dominant rams.

REFERENCES

- Banks, E. M. 1964. Some aspects of sexual behaviour in domestic sheep *Ovis aries*. Behaviour 23:249-279.
- Blockey, M. A. and B. De. 1981. Further studies on the serving capacity test for beef bulls. Appl. Anim. Ethol. 7:337-350.
- Blockey, M. A. and B. De. 1978. The influence of serving capacity of bulls on herd fertility. J. Anim. Sci. 46(3):589.
- Bourke, M. E. 1967. A study of mating behaviour of Merion rams. Aust. J. Expt. Agric. Anim. Hus. 7:203-205.
- Erhard, H. W., E. O. Price and M. R. Dally. 1998. Competitive ability of rams selected for high and low levels of sexual performance. Anim. Sci. 66(2):403-408.
- Hafez, E. S. E. 1975. The Behaviour of Domestic Animals. 3rd edn. pp. 256-265.
- Holmes, R. J. 1980. Normal mating behaviour and its variations. In: Current Therapy in Theriogenology (Ed. D. A. Morrow, W. B. Philadelphia). Saunders, pp. 931-936.
- Hulet, C. V., S. K. Ercanbrack, D. A. Price, R. L. Blackwell and L. O. Wilson. 1962a. Mating behaviour of the ram in the one-sire pen. J. Anim. Sci. 21:857-864.
- Hulet, C. V., S. K. Ercanbrack, D. A. Price, R. L. Blackwell and L. O. Wilson. 1962b. Mating behaviour of the ram in the multi-sire pen. J. Anim. Sci. 21:865-869.
- Hulet, C. V., R. L. Blackwell and S. K. Ercanbrack. 1962c. Mating behaviour of the ewe. J. Anim. Sci. 21:870-874.
- Kilgour, R. J. and R. G. Whale. 1980. The relation between mating activity of rams in pens and subsequent flock mating performance. Aust. J. Exp. Agric. Anim. Husb. 20:5-8.
- Kilgour, R. J. and C. G. Winfield. 1974. Sheep mating behaviour. NZ. J. Agric. 128(4):17-23.
- Kiyanzad, M. R., J. M. Panandam, N. Emamajameh Kashan, Z. A. Jelani and I. Dahlan. 2003. Reproductive performance of three

- Iranian sheep breeds. *Asian-Aust. J. Anim. Sci.* 16:11-14.
- Lindsay, D. R. 1966. Modification of behavioural oestrus in the ewe by social and hormonal factors. *Anim. Behav.* 14:73-83.
- Lindsay, D. R. and J. Ellsmore. 1968. The effect of breed, season and competition on mating behaviour of rams. *Aust. J. Exp. Agric. Anim. Husb.* 8:649-652.
- Lindsay, D. R., D. G. Dunsmore, J. D. Williams and G. J. Syme. 1976. Audience effects on the mating behaviour of rams. *Anim. Behav.* 24:818-821.
- Lindsay, D. R. and T. J. Robinson. 1961a. Studies on the efficiency of mating in sheep. 1. The effect of paddock size and number of rams. *J. Agric. Sci. (Cambridge)* 57:137-140.
- Lindsay, D. R. and T. J. Robinson. 1961b. Studies on the efficiency of mating in the sheep II. The effect of freedom of rams, paddock size and age of ewes. *J. Agric. Sci. (Cambridge)* 57:141-145.
- Mattner, P. E., A. W. H. Braden and J. M. George. 1971. Studies in flock mating of sheep. 4. The relation of libido tests to subsequent service activity of young rams. *Aust. J. Exp. Agric. Anim. Husb.* 11:473-477.
- Mattner, P. E., A. W. H. Braden and K. E. Tumbul. 1967. Studies in flock mating of sheep. 1. Mating behaviour. *Aust. J. Exp. Agric. Anim. Husb.* 7:103-109.
- Mattner, P. E., J. M. George and A. W. H. Braden. 1974. Herd mating activity in cattle. *J. Reprod. Fertil.* 36:454-455.
- Marincowitz, G., P. S. Pretorius and S. N. Herbst. 1966. Dominance in sexual behaviour and mating dexterity in Merino rams. *S. Afri. J. Agric. Sci.* 9:971-980.
- Meese, G. B. and R. Ewbank. 1972. A note on the instability of the dominance hierarchy and variations in levels of aggression within groups of fattening pigs. *Anim. Prod.* 14:359.
- Nawaz, M., M. Khan, M. Qureshi and E. Rasool. 1998. Production and reproductive performance of Kajli and Lohi ewes. *Asian-Aust. J. Anim. Sci.* 11:176-184.
- Patel, M., N. Das, H. N. Pandey, M. C. Yadav and P. S. Girish. 2004. Mating behaviour of rams in pen mating system. *Ind. J. of Small Ruminants* (in press).
- Schein, M. W. and M. H. Fohrman. 1954. The effect of rank separation on the intensity of the contents in dairy cows. *Bull. Ecol. Soc. Amer.* 35:74.
- Shreffler, C. and W. D. Hohenboken. 1974. Dominance and mating behaviour in ram lambs. *J. Anim. Sci.* 39(4):725-731.
- William, E. P. and M. T. Clegg. 1965. Studies of mating behaviour and some factors influencing the sexual response in the male sheep *Ovis aries*. *Anim. Behav.* XIII(2-3):244-258.