

A Behavioural Study of the Sheep and Goats of the Transhumant Gaddis

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KEYWORDS Ethology. Transhumance. Attachment. Gaddis

ABSTRACT The mobile herds of sheep and goats were the focus of study to compare the general behavioural patterns and the maternal behaviors. The study area was Bharmour, located in District Chamba of Himachal Pradesh in the north-west Himalayas. To compare the behaviour of sheep and goats techniques of naturalistic observation, using ethograms of *macro-* and *micro- units of behaviour* were used. Student's *t*-test was used to compare the sheep and goats on these units of behaviour. It was found that the two species differed on all macro-units of general behaviour patterns except one. The sheep and goats differed on 10 micro-units of maternal behaviour, but there was no difference on two behaviours. The goats grazed on the hind legs but the sheep grazed head down. The goats had lower score on moving in contact/proximity than the sheep, along with that the goats moved and rested alone to a greater degree than the sheep. The suckling was the most common behaviour in mother-infant interaction. Goat mothers were more udder rejecting than the sheep. While goats emitted greater number of low pitched bleats than the sheep; the sheep on the other hand, emitted greater number of high pitched bleats. In addition sheep exhibited greater amount of tongue manipulation of the palate and smelling than the goats.

INTRODUCTION

The Food and Agriculture Organisation of the United Nations in its report *Pastoralism in the New Millennium* (FAO 2001) has expressed deep concern about the plight of people engaged in rearing mobile herds of sheep, goats and cattle. About twenty million households were engaged in it in the various parts of the world. Though the animals reared by these pastoralists met the basic needs of milk, meat and clothing of society, there was conspicuous neglect of behavioural research on the mobile herds kept by the transhumants (Singh 2000; Pirta 2002). In the early half of twentieth century the profession of livestock has benefited from the knowledge of biologists about breeding, diseases and anatomy; customs and traditions among different pastoral groups gathered by the anthropologists; and techniques of training evolved by the comparative psychologists. The pastoralists and their flocks now need and may in turn contribute to, the advanced disciplines of cognitive science, ethology, biology, and evolutionary psychology (Kronberg and Malechek 1997; Lambe et al. 2001; Pirta 2009).

Some anthropologists have done important work on various socio-ecological and biological parameters of transhumants of the northern Himalaya, particularly the Gaddis (Bhasin et al. 2008 a,b; Bhasin 1996). However, there is lack of behavioural studies on their animals, particularly

the sheep and goats. This involves global and local issues, which range from environmental conservation (Le Houerou and Gillet 1986; Saberwal 1999) to survival of marginal populations in remote areas (Negi 2007; Noble 1987). For a student of applied animal behaviour, therefore, first of all it is important to have an idea of the population of sheep and goats in a region, for example, the Himachal Pradesh. Second important point is to understand the behaviour patterns of these animals under natural conditions (Smith 1971). For this purpose the mobile herds of sheep and goats kept under the transhumance system of pastoralism have significance (Suttie and Renolds 2003). The third important issue is the study of attachment system between mother and infant (Ainsworth and Bowlby 1991; Poindron 2005), as maternal behaviour is crucial for herding instinct and survival of the offspring. The *Capra* (goat) and *Ovis* (sheep) are two different genera which though occur together, yet exhibit striking ecological separation. Moreover, the two species have important anatomical differences therefore it is expected that the sheep and goats would differ in their general behavioural patterns and maternal behaviour.

MATERIALS AND METHODS

In order to collect data for making comparisons between the two species, the goats and the sheep,

the following study site was selected in the Chamba District of Himachal Pradesh in the north-west Himalayas.

Study Site

The study area was located in District Chamba of Himachal Pradesh in north-west Himalayas. The altitude in this region ranges from the river basin of Ravi at about 2000 meters to high mountains of Dhauladhar at 6,000 meters, and the temperature varies from -10° Celsius to 30° Celsius. The behavioural observations were conducted around the town of Bharmour, which is 62 km from Chamba. The rural township of Bharmour is inhabited by nearly 1,089 persons (Census of India 2001). Largely the population of Chamba is scattered in the rural area, with a population density of about 64 persons per square kilometer. Agriculture and horticulture are the subsidiary practices of the rural population; they are however engaged in transhumance. The families move with their herds of sheep and goats between the Shivaliks touching the Punjab planes and the high altitude mountains joining the

Tibetan plateau. In the present study the migratory route of a herd of sheep and goat was traced through interviews with transhumant pastoralists.

The two places near Bharmour served as study areas. They were Bharmani and Hadser, located in the circumference of nearly 12 km on both sides of Bharmour (Fig. 1). During the period of observations, the herds of sheep and goats were moving towards their summer pastures in the alpine area. These herds move and graze in the *nullahs* (ravines) and *dhars* (ridges). These areas are covered with forest types such as Moist Deodar, Western Mixed Coniferous forests, Moist Temperate Deciduous forests and Alpine Pastures (Singh et al. 1990). The fauna includes brown bear, Himalayan black bear, barking deer, goral, ibex, Hanuman langur, rhesus monkey, Himalayan tahr, wolf, serow and leopard. There are two sanctuaries in this region, the Kugti Sanctuary and the Tundah Sanctuary. The famous pilgrimage center of Mani Mahesh is also located in this range of mountains and is visited by thousands of devotees in the summer season. The transhumant sheep and goats graze over

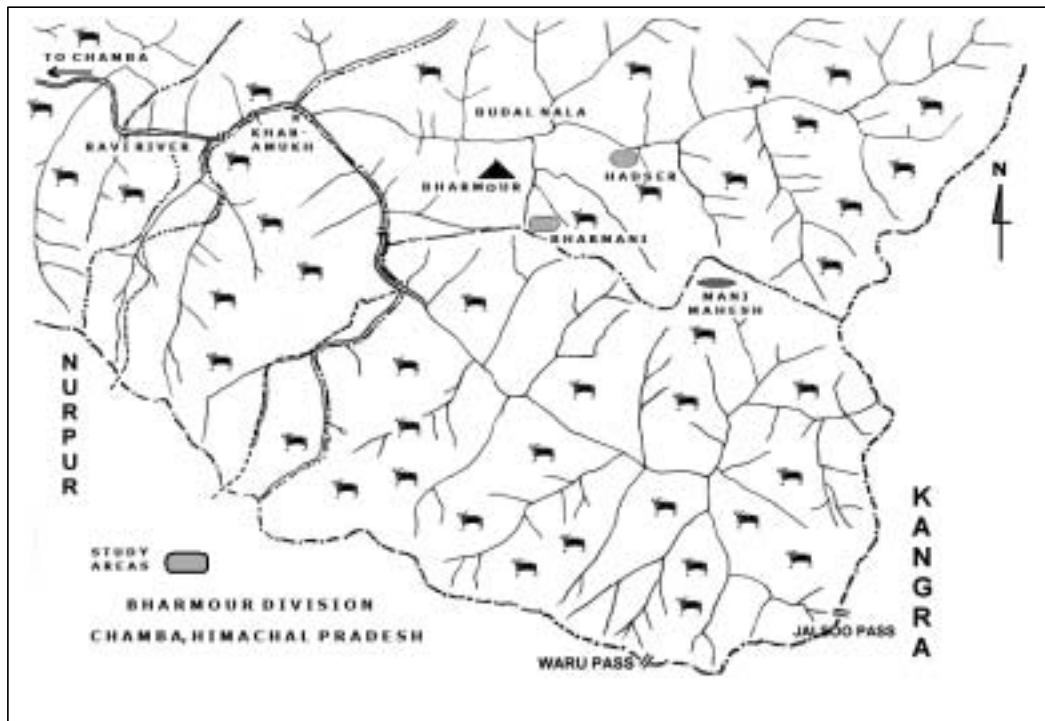


Fig. 1. Location of study areas in Bharmour, Chamba District, Himachal Pradesh.

these ranges and they belong to the Gaddis, the native pastoralists of this region. The observations were made in the months of May and June 2008. Besides that the pastoralists were interviewed to collect information regarding various issues pertaining to transhumance.

Behavioural Sampling

The objective recording of behaviour under natural and seminatural conditions has been pioneered by the ethologists. The basis of each ethological investigation is the ethogram, the precise catalogue of all the behaviour patterns of an animal. A catalogue of behaviour consists of micro-units or macro-units of behaviour depending on the objectives of the study. Various sampling methods are employed to make direct observation of spontaneous behavior in social groups of man and animals (Altmann 1974; Mitlochner et al. 2001). After making rapport with the owner of the herd, the observations were made under the free ranging conditions. In the present study our objective was to answer questions such as, do goats engage in more head down grazing than the sheep? Or, do female goats exhibit more udder rejection than the female sheep? In order to answer such questions various categories of behavior were defined and they were used to record behavior of the two kinds of animals, the goats and the sheep (Smith 1971). The categories of behaviour chosen for the present study on sheep and goats are given in table 1.

Procedure of Observation

In this preliminary behavioural study, a

technique of sampling of behavior known as one-zero sampling was used (Altmann 1974). This sampling method was developed for studying spontaneous behaviour in children. The main features of this technique are, firstly, in each sample period, occurrence or non-occurrence (rather than frequency) is recorded. Secondly, interactions of a single individual or pair of individuals are recorded in each sample period. Thirdly, the occurrence in the sample period means performance of a behavior at least once. If a behavior has occurred more than once in a sample period, it is not recorded. Thus, the score of *one* is assigned to occurrence in a sample and *zero* is assigned to non-occurrence of behavior. Therefore, the method is known as *one-zero* sampling.

The sample period in the present study was of 30-second duration and there were 20 sampling periods in a session of ten minutes. The score for a particular behavior category, for example, suckling, would be the total occurrences of suckling in a session. Therefore, the score is termed as the number of 30-second intervals.

A herd, selected for observation, during the morning or afternoon, an adult male or adult female, sheep or goat, was selected for observation. The observer used abbreviations to record the behavior on the observation sheet. Each animal was observed over five sessions, which were not necessarily consecutive. Thus, the maximum number of 30-second intervals for each sheep or goat was 100. In this way 20 sheep and 20 goats were observed from different groups, half of them were males and half were females. The same procedure was followed to make observations on maternal behavior, but the focus was on the mother-infant pair. In all 10 mother-infant pairs of

Table 1: Ethogram of macro- and micro- units of behavior for goats and sheep.

<i>General Patterns of Behaviour</i>	<i>Maternal Behaviours</i>
1. Grazing on hind legs	1. Approach
2. Grazing at shoulder level	2. Departure
3. Grazing head down	3. Social-grooming
4. Exploration	4. Suckling
5. Sheltering	5. Aggressive
6. Moving alone	6. Bleats (Low pitched)
7. Moving in contact/proximity	7. Bleats (High pitched)
8. Resting alone	8. Smelling
9. Resting in contact/proximity	9. Tongue manipulation of the palate
10. Agonistic	10. Udder acceptance
11. Sexual behaviour	11. Udder rejection
12. Maternal behaviour	12. Resting in contact/proximity
13. Any other behaviour	13. Any other behaviour

sheep and 10 mother-infant pairs of goats were observed. The mother's behavior was noted using 13 micro-units of behavior.

In order to test the significance of difference between the mean number of 30-second intervals for each *macro-* and *micro- unit of behavior* t-test was used to compare the group of goats with the group of sheep.

RESULTS AND DISCUSSION

According to 2003 animal census in Himachal Pradesh, there are 4,51,061 livestock, including 2,16,809 sheep and 1,30,441 goats. Out of which Kinnaur and Bharmour have main concentration of sheep and goats. The Kinnauras reared about 74,386 sheep and 34,635 goats (Pirta 2009). The Gaddis had about 74,971 sheep and 73,407 goats. The inception of Wool Development Board (H P) was an important event for the benefit of pastoralists. It has now a firm basis as Himachal Pradesh State Cooperative Wool Procurement and Marketing Federation (Woolfed). The objective was to improve pastoral profession through good quality animals, but the emphasis was on importing exotic breeds, no attempt has been made to improve the indigenous species (Acharya 1982) as underlined by FAO experts (see Pirta 2009).

Under the transhumance system of pastoralism, a herd of sheep and goats always remains under the open sky but it has close watch of the pastoralist and his guard dog. Though it travels a vast expanse by vertically traversing from Tibetan plateau to the Punjab plains (Fig. 2), its movement is under the control of the shepherd and a number of environmental factors. The traditional paths of these mobile herds are now extremely curtailed by developmental projects along the river courses and due to change in the forestry and agricultural practices. This would require humanistic policies based on better

understanding of ecological and social issues (Gadgil 1991; Gadgil and Malhotra 1981; McCabe 1990), in place of controversial statements, such as by Saberwal (1999). Social factors are extremely important in making decisions and determining policies as well as adoption of technologies for the management of sheep and goats.

General Patterns of Behavior

For the management of herds of sheep and goats, ethological studies are important for the improvement of reproductive efficiency. These studies provide detailed knowledge on the behaviour patterns of sheep and goats for the management of these species. A comparison on 13 macro-units of behavior was made in sheep and goats (Table 2). They differed significantly in grazing behaviour. The grazing behaviour of sheep and goats was recorded using three macro-units of behaviour: grazing on hind legs; grazing at shoulder level and grazing head down. The frequency of grazing at shoulder level and grazing on the hind legs was greater in goats than the sheep. The frequency of grazing head down was greater in sheep than the goats. The categories of gregarious behaviour were: moving in contact/proximity, moving alone, resting alone and resting in contact/proximity. The higher occurrence of resting alone and moving alone would indicate lesser gregariousness, whereas higher score on the other two categories, moving and resting in contact/proximity would indicate herding instinct. The goats had lower score on moving in contact/proximity than the sheep, along with that the goats moved and rested alone to a greater extent than the sheep. The exploration of environment is an important activity, the goats engaged in this behaviour to greater extent than the sheep. The sheltering was also greater in goats than the sheep.

Table 2: Comparison of goats and sheep for general behaviour patterns.

<i>Macro-units of Behaviour</i>	<i>Goats (Mean±SD)</i>	<i>Sheep (Mean±SD)</i>	<i>t-ratios (p)</i>
Grazing on hind legs	24.65±12.82	00.20±00.41	08.52 (.01)
Grazing at shoulder level	63.00±18.73	00.45±00.94	14.92 (.01)
Grazing head down	00.20±00.52	89.70±13.80	29.10 (.01)
Exploration	11.70±05.95	07.15±03.92	02.90 (.01)
Sheltering	01.80±05.53	00.65±01.50	00.90 (.50)
Moving alone	07.25±05.23	03.35±02.90	02.90 (.01)
Moving in contact/proximity	05.15±02.90	08.60±03.12	03.64 (.01)
Resting alone	02.55±05.45	00.75±03.12	01.28 (.50)
Mother-infant behaviour	00.70±01.22	02.05±03.72	01.54 (.50)
Any other behaviour	02.50±02.37	02.30±01.55	00.31 (n.s.)

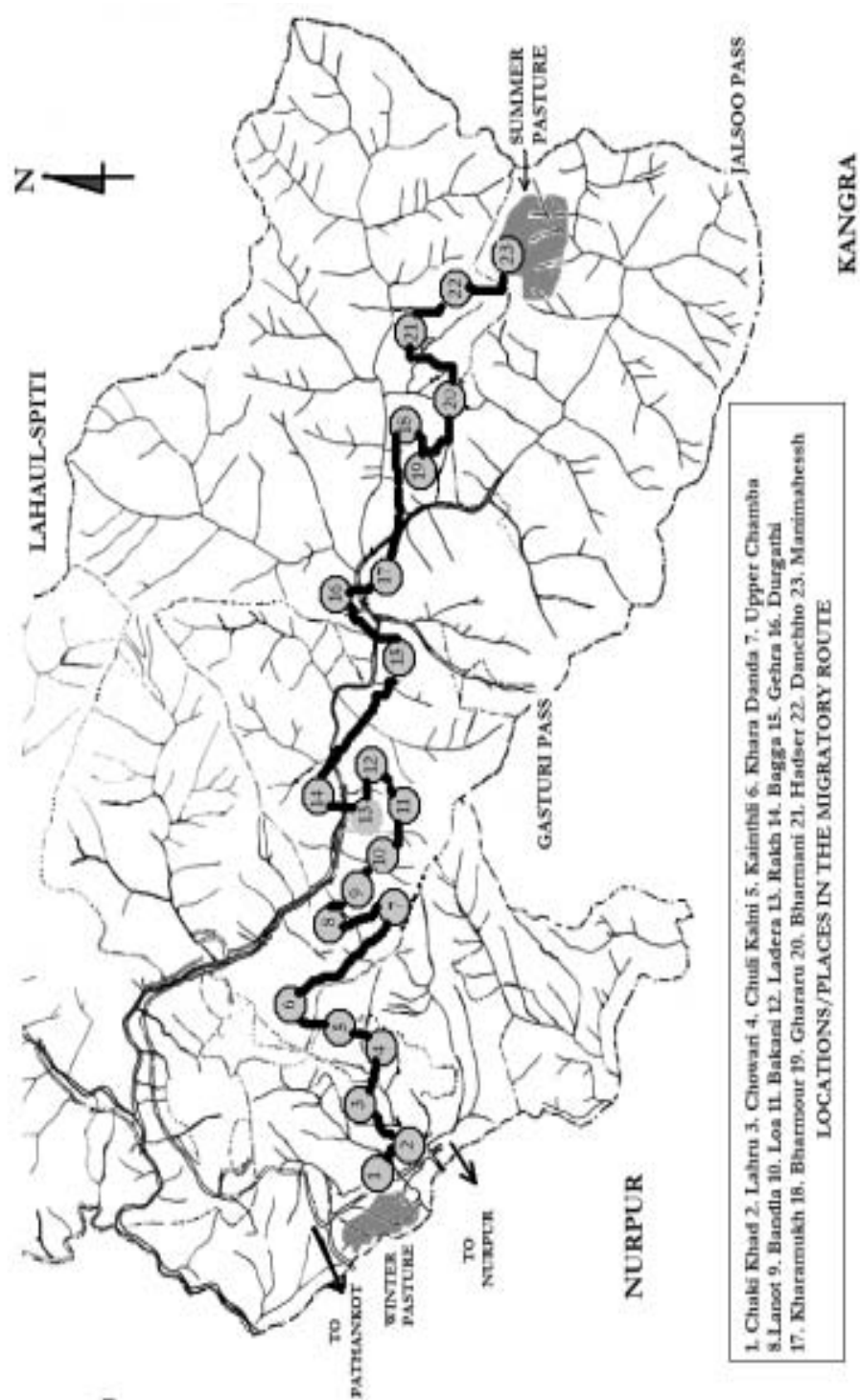


Fig. 2. The migratory route of a herd of Gaddi pastoralist.

In general, the feral sheep and goat graze in herds and thus, grazing is a social behaviour and sometimes there may be competition among the individuals of a herd. Considering the differences in grazing patterns of behaviour of the sheep and goats, these two species are being used as ecological tools for controlling noxious weeds (sheep) or reducing the incidents of fire by releasing goats to browse upon the lower branches of trees and shrubs (Chapman and Reid 2004). A study by Ashutosh, Dhanda and Singh (2002) reported the findings of observations on the grazing behaviour of native and crossbred sheep during four seasons. The crossbred animals exhibited significantly greater bite rate than the native ewes in all seasons. However, these investigators did not break the grazing into three categories as was done in the present study.

Shi and Dunbar (2006) investigated feeding competition within and between different age-sex classes of feral goats on the Isle of Rum. Keeping the fact that large herbivores feed on widely dispersed resources, the aggression between members within a group was relatively unimportant. In the present study, the investigators found that the occurrence of dominance, sexual behaviour and resting in contact/proximity were negligible. This was due to short duration of observation in the present study. Though forestry people are reluctant to allow livestock grazing in forest plantations, the growth of the planted species is many a times retarded by competing grasses and other weeds. The sheep and goats keep the growth of these competing species of plants under control (Chapman and Reid 2004).

Maternal Behaviour

Following Pavlov's work on dogs in Russia,

Liddell (1925) and his coworkers in the United States did a series of experiments on sheep and goats to further explore the principles of experimental neuroses, which pioneered the Behavior Therapy. The presence of mother was instrumental in alleviating the development of neurotic behaviour in young lamb or kid (Patton 1964). Therefore it is important to develop an ungulate model of attachment behaviour. Comparisons on 13 micro-units of maternal behaviour were made between sheep and goats (Table 3). The frequency of suckling was highest and most common behaviour in mother-infant interaction. There was no significant difference between goats and sheep on this category. The goats showed greater amount of resting in contact/proximity behaviour than the sheep. The sheep mothers allowed greater amount of udder acceptance than the goats. But the goat mothers were more udder rejecting than the sheep. While goats emitted greater number of low pitched bleats than the sheep; the sheep on the other hand, emitted greater number of high pitched bleats. The sheep mother approached their young more than the goats. The goats on the other hand, made greater number of departures from their infants. In addition, sheep exhibited greater frequency of tongue manipulation of the palate and smelling than the goats.

These findings have importance in developing an ungulate model of attachment behaviour, but first of all it has significance for the healthy growth of the herd itself. The flocks of sheep and goats kept by the transhumant pastoralist provide far better conditions for these animals in comparison to the stall fed animals. A significant thing in group living animals is the familiarity among the animals. Under natural conditions the groups of animals remain intact and the members do not leave their

Table 3: Comparison of Goats and Sheep for maternal behaviour.

Macro-units of behaviour	Goats (Mean±SD)	Sheep (Mean±SD)	t-ratios (p)
Approach	02.70±01.70	05.30±02.62	2.62 (.05)
Departure	06.00±02.53	02.60±01.50	3.64 (.01)
Social grooming	00.50±01.51	00.60±01.57	0.18 (n.s.)
Suckling	45.70±08.53	47.20±11.35	0.33 (n.s.)
Bleats low pitched	03.60±10.00	00.60±01.07	3.77 (.01)
Bleats high pitched	00.20±00.67	04.30±03.77	3.41 (.01)
Smelling	02.00±05.51	03.10±01.37	2.01 (.10)
Tongue manipulation of palate	01.60±04.57	03.70±03.16	1.89 (.10)
Udder acceptance	03.40±09.31	05.60±02.17	2.72 (.01)
Udder rejection	04.70±13.00	01.60±00.96	3.45 (.01)
Resting in contact/proximity	31.30±12.17	19.50±12.32	2.15 (.05)
Any other social behavior	10.00±27.90	20.80±12.10	2.45 (.05)

group. Change of group membership or the introduction of new member results in aggression. Every herder or animal keeper takes care when he introduces new animals to flock. Frequent changes affect the psycho-logical health of the sheep and goats deleteriously: firstly, because of the separation from the companions, and secondly, due to change in the frequency of social interactions among the members owing to entry of new members. In both cases, a change in group acts as social stressor that have short-term (injuries) and long-term (exclusion from food or mating partners) effects. The continuous social stress may change the immune responses of the animals and, thus, make them prone to diseases.

In a study by Booth and Katz (2000), interesting experiments were designed to evaluate the role of vomeronasal organ in neonatal offspring recognition in sheep. The behavioural measure, frequency of low-pitched bleat and high-pitched bleats emitted by ewes differed after the damage to vomeronasal organ. It has been observed in the parturient goats that they rapidly develop exclusive nursing of their own litter, which is mainly based on olfactory recognition of the young. Not only that the sensory stimulation from the young strongly inhibits the resumption of postpartum sexual activity (Hernandez et al. 2004). Above all the mother-infant interactions are important in the survival of the offspring (Nowak et al. 2000). The maternal care and nursing of the offspring is a defining characteristic of mammals. Lack of maternal care has severe psychopathological effects on the behaviour of the developing infant and social life of the group.

To summarize, there are some interesting studies by the biologists and social scientists on pastoralists in western Himalayas (Hoon 1996; Khatana 1992; Negi 2007; Noble 1987; Rodgers 1991; Saberwal 1999), but the research on behavioural aspects of sheep and goats is an imperative (Diamond 2002). The socio-religious systems that they have developed in the remote regions of the world, particularly in the western Himalaya, have enormous diversity of socio-psychological material (Bhasin 1996; Pirta 2007; Pirta and Ranta, 2007; Singh 2003). Thus, there is need to rethink, about the survival of these transhumance systems, as they are reservoirs of biological and cultural diversity.

The findings of the present study have important suggestions for future research. First, it is important to replicate these observations at

some other location such as the winter pasture. If the differences in the general behavioural patterns are consistent this would highlight the species specificity. Second, considering transhumance as a complex system of human-animal relationships the findings related to movement of herd, environmental degradation and disturbances due to developmental changes underlie the need for socio-cultural and ecological research. Third, an important area of current research is to develop animal models of attachment that have theoretical and applied significance. Our findings suggest that sheep and goats provide two different ungulate models of attachment.

REFERENCES

- Acharya RM 1982. *Sheep and Goat Breeds of India*. Rome: Food and Agriculture Organization of the United Nations.
- Ainsworth MDS, Bowlby J 1991. An ethological approach to personality development. *Amer Psychol*, 46: 333-341.
- Altmann J 1974. Observational study of behavior: Sampling methods. *Behav*, 49: 227-267.
- Ashutosh, Dhanda OP, Singh G 2002. Changes in grazing behaviour of native and crossbred sheep in different seasons under semi-arid conditions. *Trop Anim Health Prod*, 34: 399-404.
- Bhasin MK, Singh IP, Shil AP, Singh, R, Bhasin V, Chahal, SMS 2008a. Genetic Studies of Pangwalas, Transhumant and Settled Gaddis: Age changes in biological variables among Pangwalas of Pangti Tehsil, Chamba District, Himachal Pradesh. *J Hum Ecol*, 24: 139-147.
- Bhasin MK, Singh R, Singh IP, Bhasin V, Chahal SMS 2008b. Genetic Studies of Pangwalas, Transhumant and Settled Gaddis: A comparative study of age changes in biological variables among Transhumant and Settled Gaddis. *J Hum Ecol*, 24: 149-174.
- Bhasin V 1996. *Transhumants of Himalayas. Changpas of Ladakh, Gaddis of Himachal Pradesh and Bhutiyas of Sikkim*. Delhi: Kamla-Raj Enterprises.
- Booth KK, Katz LS 2000. Role of the vomeronasal organ in neonatal offspring recognition in sheep. *Bio Reprod*, 63: 953-958.
- Chapman CK, Reid CR 2004. *Sheep and goats: Ecological tools for the 21st century*. Extension, Utah State University, May.
- Diamond J 2002. Evolution, consequences and future of plant and animal domestication. *Nature*, 418: 700-707.
- FAO 2001. *Pastoralism in the New Millennium*. Rome: Food and Agricultural Organisation of the United Nations.
- Gadgil M 1991. Ecological organization of the Indian society. *ICSSR News Letter*, XXI: 1-9.
- Gadgil M, Malhotra K 1981. What prize is development? *Science Today*, February.
- Hernandez H, Delgadillo AJ, Serafin N, Rodriguez AD, Poindron P 2004. Prepartum peripherally-induced

- hyposmia does not reduce postpartum anoestrous duration in nursing goats. *Reprod Nutr Dev*, 44: 251-259.
- Hoon V 1996. *Living on the Move: Bhotias of the Kumaon Himalaya*. Sage: New Delhi.
- Khatana RP 1992. *Tribal Migration in Himalayan Frontiers: Study of Gujjar Bakarwal Transhumance Economy*. Gurgaon: Vintage Books.
- Kronberg SL, Malechek JC 1997. Relationships between nutrition and foraging behaviour of free-ranging sheep and goats. *J Anim Sci*, 75: 1756-1763.
- Lambe NR, Conington J, Bishop SC, Waterhouse A, Simm G 2001. A genetic analysis of maternal behaviour score in Scottish Blackface sheep. *Anim Sci*, 72: 415-425.
- Le Houerou HN, Gillet H 1986. Conservation versus desertification in African arid lands. In: ME Soule (Ed.): *Coservation Biology: The Science of Scarcity and Diversity*. Massachusetts: Sinauer Associates, pp. 444-461.
- Liddell HS 1925. The behavior of sheep and goats in learning a simple maze. *Amer J Psychol*, 36: 544-552.
- McCabe JT 1990. Turkana pastoralism: A case against the tragedy of commons. *Hum Ecol*, 18: 81-103.
- Mitlohner FM, Morrow-Tesch JL, Wilson SC, Dailey JW, McGlone JJ 2001. Behavioral sampling techniques for feedlot cattle. *J Anim Sci*, 79: 1189-1193.
- Negi VS 2007. *The Nomadic Shepherds of North-West Himalayas: In the Context of Kinnaur* (A Socio-cultural Study). Sarnath, Varanasi: Central Institute of Higher Tibetan Studies. (in Hindi)
- Noble C 1987. *Over the High Passes. A Year in the Himalayas with the Migratory Gaddi Shepherds*. London: Collins.
- Nowak R, Porter RH, Levy F, Orgeur P, Schaal B 2000. Role of mother-young interactions in the survival of offspring in domestic animals. *Rev Reprod*, 5: 153-163.
- Patton RA 1964. Abnormal behavior in animals. In: CP Stone (Ed.): *Comparative Psychology*. New Delhi: Prentice-Hall of India, pp. 458-513.
- Pirta RS 2002. Comparative psychology: Understanding behaviour of non-human primates. *Psychol Stud*, 46: 25-37.
- Pirta RS 2007. *Ecology and Human Well-being: Nature and Society in Himachal Pradesh*. Delhi: Shipra Publications.
- Pirta RS 2009. *Pastoralism and the Tribesman of Mountain: The Arung Zet Sa of Kanaor*. Delhi: Shipra Publications.
- Pirta RS, Ranta RS 2007. Social conflicts and possession: The role of reconciliation processes mediated by local deities. *J Ind Acad App Psychol*, 33: 201-212.
- Poindron P 2005. Mechanisms of activation of maternal behaviour in mammals. *Reprod Nutr Dev*, 45: 341-351.
- Rodgers WA 1991. Environmental change and the evolution of pastoralism in South Asia: A discussion. *Stud Hist*, 7: 195-204.
- Saberwal VK 1999. *Pastoral Politics: Shepherds, Bureaucrats and Conservation in the Western Himalaya*. Delhi: Oxford University Press.
- Shi J, Dunbar RIM 2006. Feeding competition within a feral goat population on the Isle of Rum NW Scotland. *J Ethol*, 24: 117-124.
- Singh M 2000. Animal behaviour. In J Pandey (Ed.): *Psychology in India Revisited: Developments in the Discipline (Vol. 1): Physiological Foundation and Human Cognition*. New Delhi: Sage, pp. 19-57.
- Singh S, Kothari S, Pande P (Eds.) 1990. *Directory of National Parks and Sanctuaries in Himachal Pradesh. Management Status and Profiles*. New Delhi: Indian Institute of Public Administration.
- Singh U 2003. *Between Worlds: Travels Among Mediums, Shamans and Healers*. New Delhi: Penguin.
- Smith FV 1971. *Purpose in Animal Behaviour*. London: Hutchinson University Library.
- Suttie JM, Reynolds SG 2003. *Transhumant Grazing Systems in Temperate Asia*. Rome: Food and Agriculture Organization of the United Nations.