EPIDEMIOLOGY AND CONTROL OF PARASITISM IN NOMADIC SITUATIONS IN HIMACHAL PRADESH

K.P. Jithendran and T.K. Bhat
Indian Veterinary Research Institute, Regional Station, Palampur (H.P.) 176 061

INTRODUCTION

Location, geography and climate

The state of Himachal Pradesh is situated south of Jammu and Kashmir, north-east of Punjab, north-west of Haryana and Uttar Pradesh and west of Tibet, between latitude 30^{o} 22' 40" N and 33^{o} 12' 40" N and longitude 75^{o} 45' 55" E and 79^{o} 04' 20" E with an altitude ranging from 350 m (low valleys) to 6,975 m (snow covered mountains) above mean sea level. Geographically the state is located in the North Western Humid Himalayan Region (NWHHR) comprising Jammu & Kashmir, Himachal Pradesh and 8 hill districts of Uttar Pradesh. It has a total geographical area of 56,673 square kilometers including 9859 square kilometers of permanent pastureland. The climatic conditions vary from hot and sub-humid tropical in southern low tracts, (450-900 m), warm and temperate (900-1800 m), cool and temperate (1900-2400 m) and cold alpine and glacial 2400-4800 m) in the northern and eastern high mountain ranges. The rainfall varies from 350 to 3800 mm per annum with temperature varying from -25^{o}C in January to 42^{o}C in June. The region is well known for its biodiversity (Anonymous, 1985).

Agroclimatic zones

Agroclimatically the state is divided into 4 zones on the basis of topography, rainfall and altitude (Figure 1).

Zone I	Submountainous low hills-subtropical (upto 1,100 m)
Zone II	Mid hills-subhumid (1,100- < 2,000 m)
Zone III	High hills temperate wet (2,000- < 3,000 m)
Zone IV	High hills temperate dry (> 3,000 m)

Livestock and wild animals

About 92 % population in Himachal Pradesh is rural and depends directly on agriculture, horticulture and animal husbandry (Anonymous, 1994). The rearing of livestock is an integral component of the economy of the state providing source of livelihood to most of the people, especially those inhabiting the border districts of Lahaul-Spiti, Kinnaur, Pangi and Bharmour sub division of Chamba and Bara Bangahal area of Kangra. In the remaining areas, livestock rearing is practiced generally within the framework of mixed farming. The state has a total livestock population of 50.93 lakh constituting 21.9 lakh cattle, 6.2 lakh buffaloes, 10.7 lakh sheep and 11.0 lakh goats and roughly about 1 lakh other animals (equines, mithun, yak, camel, pig, rabbit etc.) excluding poultry against total human population of 51.11 lakh living in 16,807 inhabited villages (Table. 1). Owing to differing climate in the state, it has a variety of wild life. The carnivorous animals include leopard, panther, hyena, ibex, jackal, wild dog, yellow jungle cat, fox, wolf, and marmot. Other animals are sambar, cheetal, barking deer, chausingha, ghural and hog deer. Kastura (musk deer) is found at high altitudes and hares, jungle fowl, peafowl, partridges and quails are plentiful in the lower hills. Kali pheasant is found in the low slopes and monal (snow pheasant), the state bird at high snowy altitudes (Mittoo, 1993).

Migration of livestock in Himachal Pradesh

In Himachal Pradesh, animals are kept in a wide variety of husbandry systems and in different numbers - from a single cow kept for the family to large herds and flocks maintained in a range of systems. Transhumance over long distances, from the Punjab and to the alpine meadows of the inner Himalaya is an established practice although these practices are changing in the contemporary period. Chakravarti (1998), Duffield *et al*. (1998) and Berkes *et al*. (1998) give a detailed account of transhumance in the Himalayan pasture (Figure 2). The migration is essentially practiced by people living in mountain locked backward and tribal areas which mainly include *Gaddis* and *Gujjar* tribes to find better fodder for the flocks. The traditional sheep and goat rearers called *Gaddis* are semi-nomadic (rather than nomadic

because they combine the seasonal movement of livestock with seasonal cultivation) tribal Hindu group who practice long distance herding of sheep and goats from range to range and their flocks are migratory in nature through well defined routes in Himalayan pasture (Bhasin and Singh, 1995). These animals remain confined to the low plains in zone I and II and border areas of Punjab during the winter season, but migrate to the alpine pasture land (3,000- 4,500 m above m.s.l.) in zone III and zone IV during spring and summer seasons. Shepherds of the snowy ranges are the best description of the *Gaddis* of the alpine terrain of Himachal Pradesh. The alpine zone is the *Gaddis* niche. It is a narrow geographical belt running unevenly across the north western Himalaya, with a area of approximately 19,000 km^2 in H.P. Although Gaddis keep permanent dwellings in the Kangra valley, the *Gujjars* are a Muslim buffalo herding community / tribe which follows a system of high pasture use throughout the Himalaya. They are semi-nomadic pastoralists, and have permanent homes where some families remain to tend to crops while other families take the animals to high pastures.

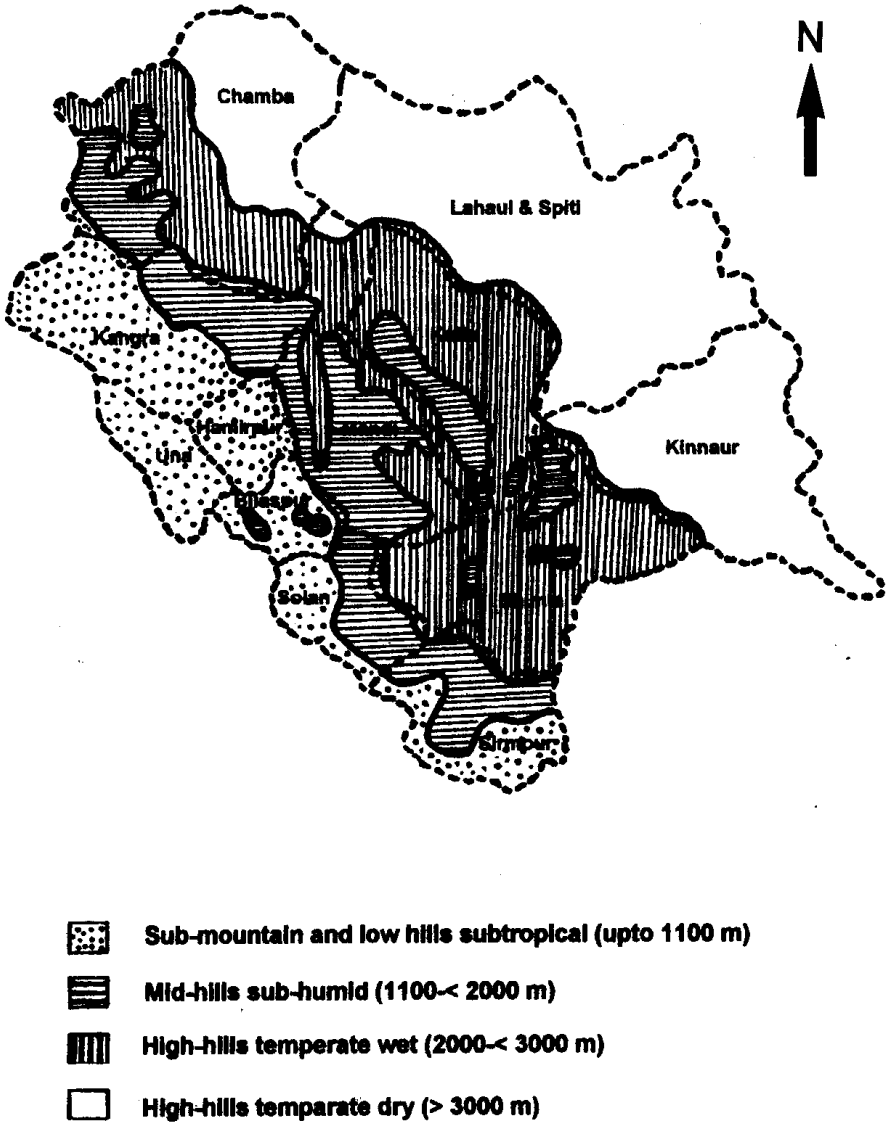

Figure 1: Agroclimatic zones of Himachal Pradesh

Table 1: District wise livestock population in Himachal Pradesh (1992 census)

District	Cattle	Buffalo	Sheep	Goat	Dog	Others	Total	Poultry
Bilaspur	60,461	86,858	24,615	63,472	8,770	1,309	2,45,485	58,844
Chamba	2,38,988	34,832	2,58490	1,75,268	14,730	2,800	7,25,108	67,871
Hamirpur	60,671	94,089	49,498	30,719	8,500	1,783	2,45,260	28,810
Kangra	3,98,558	1,47,386	1,55,432	2,05,024	32,448	10,544	9,49,392	2,42,681
Kinnaur	20,937	3	57,720	28,622	2,182	4,358	1,13,822	5,795
Kullu	1,57,448	670	1,09,835	56,382	9,062	1,379	3,34,778	21,315
Lahul & Spiti	8,910	-	42,766	11,445	205	3,405	66,731	4,923
Mandi	4,30,331	1,07676	1,96,041	2,03,270	14,184	5,155	9,56,657	81,363
Shimla	3,29,055	23,258	1,26,531	95,831	16,469	5,866	5,97,010	45,082
Sirmaur	2,35,557	40,108	27,616	1,15,915	14,850	4,586	4,38,632	39,475
Solan	1,43,491	74,349	19,713	82,541	10,304	3,042	3,33,440	46,167
Una	67,209	91,694	6,088	47,100	13,731	826	2,26,648	21,776
H.P. (Total)	67,51,616	7,00,923	10,74,345	11,15,591	1,45,435	45,053	52,32,963	6,64,039

Source – Directorate of Economics and Statistics, Shimla (Himachal Pradesh), 1994.

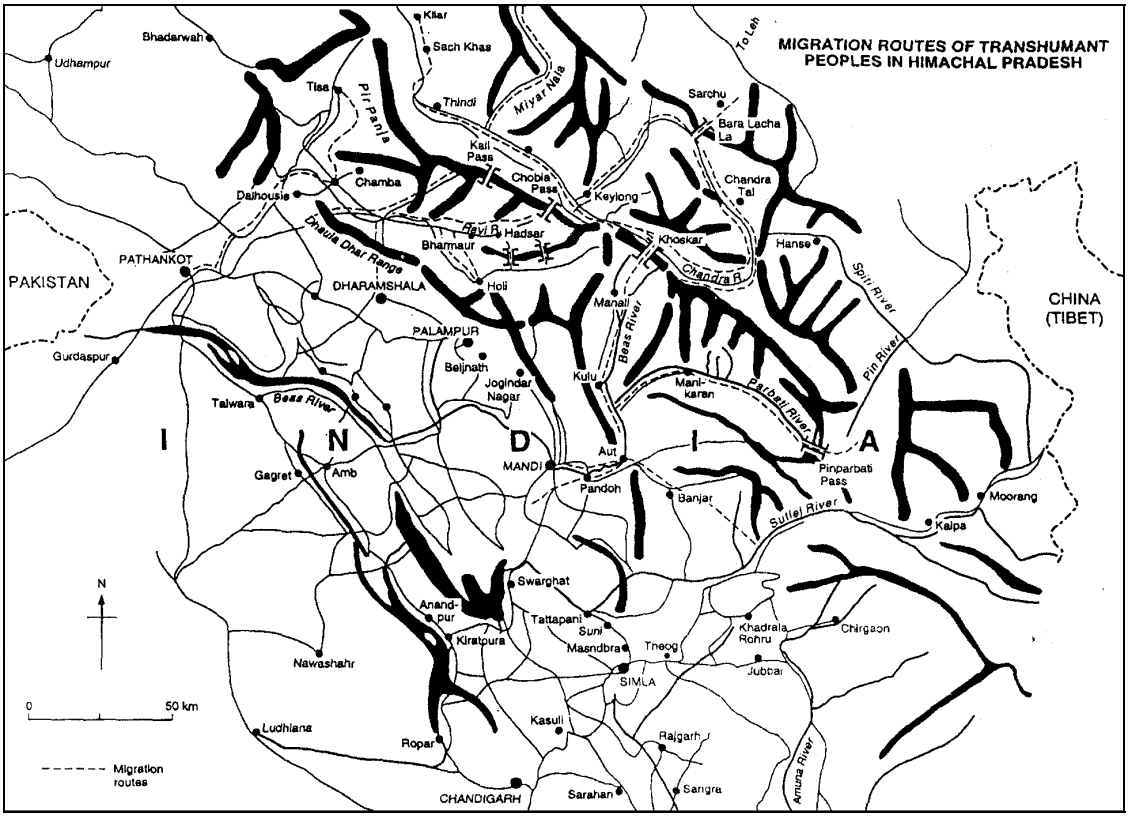

Figure 2: Migration routes of transhumant people in Himachal Pradesh [Source: M. Chakravarty-Kaul, 1998]

Epidemiology of parasitic infections in nomadic populations

Nomads are people characterised by or leading a wandering life: pastoral nomads move in search of pasture for their herds; semi-nomads practice unspecialised herding and farming; whilst transhumance is the seasonal moving of livestock to regions of different climate. Depending on the definition employed, there are between 50-100 million nomads in the world mainly in Africa, Middle East, India, and central Asia (Omar, 1992; Macpherson, 1994). Nomadism is a highly specialised mode

of life enabling humans to exploit resources that are widely distributed over space and time. Most pastoral nomads maintain a range of livestock divided in separate units capable of utilising all the grass cover in each locality. Livestock species comprise cattle, buffalo, sheep and goats besides yak and other transport animals to increase their efficiency.

Parasitism is one production problem limiting the animal productivity in these animals and the effect of parasitism may be more in areas of high moisture and rainfall and where permanent pasture situation exists and feral and semi-feral grazing system are practiced. Till seventies, the state of Himachal Pradesh was considered as a disease free zone. This concept emanated from lack of proper diagnostic facilities in the region. The paucity of studies is due to a number of factors including remoteness of some of the areas and lack of infrastructure or trained personnel. The nomad's isolation and adaptation to harsh ecological conditions prevailing in the region is in fact a hardship post for staff who are often forced to work there. The constant movement of flocks of sheep and goats and their constant interaction with other domestic and wild animals over a large area ranging different states may greatly facilitate the spread of infection among livestock as well as human beings.

Environmental factors

Environmental conditions, especially relative humidity and temperature have a profound effect on the global distribution of parasite species (Hinz, 1986) and would be an important limiting factor for parasitic infections in the environment occupied by most nomadic peoples. The southwest monsoon sets in July and ends in September with the highest rainfall in August. The rise in parasitic load could be attributed to a more favourable temperature, humidity for the development and survival of the pre-parasitic stages (Durie, 1961) leading to increased availability of infective larvae on the pasture during the subsequent months.

Those parasites with free-living stages (e.g. *Giardia* spp*., Entamoeba* spp. and nematodes such as *Trichuris* spp., Trichostrongyloidea, Strongyloidea, Ascaroidea) are markedly influenced by environmental conditions. Similarly, parasites with numerous freeliving stages, most nematodes and cestodes and those with homothermic intermediate hosts (*Sarcocystis, Echinococcus, Taenia* spp.) are influenced by environmental climatic conditions. Parasites without free living stages or the requirement of vectors or intermediate hosts for e.g. *Trichinella* spp. and those parasites with vertical mode of transmission (38 helminth parasites and many protozoans) are more independent of environmental factors. Absence of free living stages removes it from the vicissitudes of the environment and from finding a suitable host at appropriate stage of development. Pregnancy and lactation are discrete, often seasonal phenomena. So there is need for such parasite species to synchronise the larvae for passage at specific times. This is achieved by arrested development and production of offspring when conditions are too extreme, a mechanism known as hypobiosis. This is an important survival strategy for members of the superfamily Trichostrongyloidea and some genera of the superfamily Strongyloidea. Hypobiosis also allows species whose adults have limited life spans for e.g. *Toxocara canis*, to survive in the hosts for extended periods, and to correlate the resumption of development with parturition or lactation when immunologically naive young are available.

Human behavior in relation to disease transmission

Among the most important factors influencing the transmission of parasitic disease is human behavior. Nomadic pastoralists have the closest possible association with their own ecosystem. The low population density, mobility, eating habits, lack of sanitation, dwelling construction and intimate association with their animals, all have a profound influence on the transmission of parasites.

Helminths do not as a rule multiply within the host and the number of parasites is a function of the frequency of infection. Ingestion and percutaneous penetration, two major routes of entry of parasites are influenced by behavior of the prospective human host. This may be active, as ingesting soil containing infective stages of *Toxocara canis*, *Ascaris* spp., *Trichuris* spp. or *Ancylostoma* spp. or permissive, as exposing the skin to water containing penetrative larva of *Schistosoma* spp or soil containing larvae of *Necator* spp. or *Strongyloides* spp. Human and animal cestode infections may result

from ingestion of eggs directly from the faeces of definitive hosts or indirectly by contact with definitive hosts or from contaminated food, water, soil or eating utensils.

There is a close contact of man and animals in the tribal areas of Himachal Pradesh, where domestic animals are kept in basement of the house with human occupants in the first floor of same house. In addition Gaddis (semi-nomadic tribe) also remain in close contact with sheep, goat and dogs throughout the year, exposing them to many animal born diseases of occupational risk. The association of dogs with migratory flock might be playing an important role since they accompany the flock all through the valley and alpine pastures and also feed on dead/offal of slaughtered sheep and goat, though sylvatic cycle cannot be totally ruled out (Jithendran and Rao, 1996). The authors encountered situations, where nomads and butchers use the fluid from big hydatid cysts (potentially hazardous) at the site of slaughter. Snacks made from the whole blood collected from the sheep/goat at the time of slaughter is also a delicacy among the migratory tribes. Their migratory life style is likely to have no access to permanent educational, medical, and veterinary health services. They also may not have safe and sanitary water supplies leading to many zoonotic diseases.

Risk factors in acquiring parasitic infections during travel to infested areas of the region has been recorded in several instances. Increased thrust on travel tourism and pilgrimage tourism has enhanced the exposure of the public to these infections. Further, the scaling up of infection in tourists living in tents or native dwelling in rural settings and vast number of wild animals in thick belt of forest at high mountains, results in contamination of environment and infections are contracted either through contaminated food or untreated water which is common feature in the hilly regions.

Human diseases in nomadic situations

Table 2 is a summary of the intestinal parasites, found on stool specimen examination, in their order of importance. Some are parasitic zoonoses, which are naturally transmissible from animals to man by various means (Table 3). Zoonoses involving parasites are both common and important, some causing serious diseases of widely varying severity from asymptomatic to fatal. Most of the parasitic zoonoses are acquired through contaminated food and water manifesting in subclinical forms; as a result, it is difficult to visualise the magnitude of the disease problem.

Table 2: Parasites reported from human beings in Palampur area in Himachal Pradesh

Organism	Location	References
Protozoa		
Giardia lamblia	Intestine	Personal observation
Entamoeba histolytica	Intestine	Personal observation
Cestodes		
Taenia spp.	Intestine	Personal observation
Hymenolepis spp.	Intestine	HPKV Annual report, 1991-92
Nematodes		
Ascaris lumbricoides	Intestine	HPKV Annual report, 1990-92
Enterobius vermicularis	Rectum	Personal observation
Ancylostoma spp.	Intestine	Personal observation
Trichuris spp.	Intestine	Personal observation

The cystic stage of the tapeworm *Echinococcus granulosus* is common in sheep, goat, cattle and buffaloes. Hydatidosis due to the larval stages of *Echinococcus granulosus* is of great public health importance. Primarily, the domestic herbivorous animals serve as intermediate hosts and rarely produce clinical signs despite heavy infection. Hence the metacestode infections are usually diagnosed at necropsy. Based on a survey in abattoir, sheep and goats revealed 4.4 % infection with hydatid cysts with size ranging from 2 to 4 cm and with high percentage (70 %) of viable cysts (Jithendran, 1996). Jithendran and Rao (1996) discussed the role of nomadic flocks in the spread of zoonotic helminthic infections.

Table 3: Directly transmitted zoonoses caused by helminth parasites in Himachal Pradesh

Parasite	Vertebrate host	Diseases
Cestodes		
Echinococcus	Dog	Hydatid
Nematodes		
Ancylostoma spp.	Dog	Cutaneous larva migrans
Toxocara	Dog	Visceral larva migrans

Man is both a final and an intermediate host for *Taenia solium,* with chances of autoinfection. There are already reports of *Cysticercus cellulosae* infection in pigs of Kangra valley. However, in areas where villages are not supplied with sanitary facilities, wild pigs come in contact with human excreta. Illegal killing and eating of these animals further perpetuate the life cycle of *T. solium*. Heavy infection of dogs with fleas and *Dipylidium caninum* also helps in spreading infection of *D. caninum* to children, by accidental ingestion of dog flea containing cysticercoid, while playing with dogs. Similarly, observation of *Hymenolepis diminuta* in rats and man of Kangra area also suggest of zoonosis. *Enterobius* spp. infection is perhaps the most common helminthic diseases endemic in migratory lifestyle. Cutaneous and visceral larva migrans are also reported among children. Ascarid infections occur occasionally in children who generally, but not exclusively, have been associated with pigs. *Cysticercus cellulosae* have also been recorded in muscles and heart of pig at Kangra valley. Besides this, protozoan infections of *Entamoeba* and *Giardia* spp. are most prevalent in the region.

The various helminthic infection encountered in dogs of Himachal Pradesh are *Toxocara canis, Ancylostoma caninum, Dipylidium caninum* and less important filariid heart worm (*Dirofilaria immitis*) and whip worm (*Trichuris vulpis*). Infection of *Toxocara* and *Ancylostoma* species are of great importance in pups, whereas adults either suffer from acute course or sub latent infection and act as immune carriers contaminating kennels and other surroundings and thus transmitting the diseases in young litters, pet owners and children. Majority of canine helminthic diseases escape early detection due to non-specific symptoms.

Clinical manifestations of parasitic diseases

The most common symptoms of intestinal parasitic infections are constipation or diarrhoea. Diarrhoea may be bloody or purulent. Cramping abdominal pain may be predominant feature in those diseases in which the bowel mucosa or wall is invaded by the parasite, such as hookworms. Heavy infections with *Ascaris* can result in obstruction of the gut. Patients with tapeworms may be asymptomatic, except for weight loss despite increased appetite and food intake.

Peripheral blood eosinophelia (15-50 %) is one of the most important markers for parasitic infections. However, the lack of eosinophils in either the blood or body fluids does not preclude the diagnosis of parasitic infections in which eosinophilia is not a common manifestation or the load of the parasites may be very low.

Wild life diseases shared by nomadic pastoralists

Close contact facilitates exchange of many zoonotic diseases (protozoan, entomological and helminthic) and non- zoonotic diseases. Often nomadic pastoralists eat wild animals. Studies on parasitism of wild life are scanty and some of the parasites reported from captive wild and zoo animals is shown in Table 4. Wild animals occur in abundance and diversity, particularly in areas inhabited by nomadic pastoralists. Wild animals increase the number of definitive and intermediate host species, expanding the number parasite's range over space and time. The occurrence of parasite infections in wild life reservoirs complicates control efforts.

Table 4: Incidence of some gastrointestinal helminth parasites in wild/zoo animals in Himachal Pradesh

Parasite	**Host**	**Location**	**Reference**
Toxascaris leonina	Lion, leopard	Intestine	Kishtwaria *et al*., 1998
Toxascaris spp.	Lion cub	Intestine	Agnihotri *et al*., 1998
Toxocara spp.	Lion cub	Intestine	Agnihotri *et al*., 1998,

			Kishtwaria *et al*., 1998
Strongyle spp.	Lion cub	Intestine	Agnihotri *et al*., 1998
Muellerius capillaris	Deer	Lung	Sharma *et al*. 1996
Taenia taeniaformis	Leopard/cat	Intestine	IVRI Annual report,1997-98; Jithendran and Somvanshi,1997
Raillietina tetragona	Dove, mynah, House sparrow		
	Pigeon, parrot	Intestine	Chahota *et al*., 1997
Cotugnia digonopora	Pigeon	Intestine	Chahota *et al*., 1997
Spirometra spp.	Leopard	Intestine	IVRI Annual report, 1997-98
Ancylostoma spp.	Leopard, lion	Intestine	IVRI Annual report, 1997-98, Kishtwaria *et al*., 1998
Capillaria hepatica	Monal, rodents	Liver	HPKV Annual report, 1990-91, Chahota *et al*.,1997
Ascaridia spp.	Monal	Intestine	HPKV Annual reports, 1990-91
Cyathostoma spp.	Nightingale	Air sac	Chahota *et al*., 1997

Table 5: Parasites in dairy cattle and buffaloes in Palampur (Himachal Pradesh)

Parasites	No (%) infected*			
	1986-1990		1993-97	
	Cattle (n=1552)	Buffalo (n=530)	Cattle (n=1407)	Buffalo (n=107)
Flukes				
Fasciola spp.	559 (36.0)	258 (48.7)	88 (6.3)	22 (20.6)
Amphistome spp.	257 (16.6)	81 (15.3)	212 (15.1)	12 (11.2)
Dicrocoelium spp.	177 (11.4)	99 (18.7)	29 (2.1)	2 (1.9)
Schistosoma spp.	9 (0.6)	2 (0.4)	0 (0.0)	0 (0.0)
Cestodes				
Moniezia spp.	45 (2.9)	15 (2.8)	12 (0.9)	2 (1.9)
Nematodes				
Strongyle spp.	487 (31.4)	155 (29.2)	190 (13.5)	17 (15.9)
Strongyloides spp.	142 (9.1)	22 (4.2)	24 (1.7)	6 (5.6)
Toxocara spp.	69 (3.9)	24 (4.5)	27 (2.1)	2 (1.9)
Dictyocaulus spp.	30 (1.9)	3 (0.6)	9 (0.7)	0 (0.0)
Trichuris spp.	81 (5.2)	12 (2.3)	21 (1.6)	0 (0.0)
Capillaria spp.	21 (1.4)	6 (1.1)	12 (0.9)	0 (0.0)

* Total numbers and total percentage of animals exceed expected values owing to multiple parasitism

Parasite control programme for nomads

Progress in nomadic communities is hindered by lack of adequate epidemiological data on parasitic diseases. The most appropriate, practical and cost effective methods to deliver health and veterinary care to nomadic population and their livestock is still a matter of debate. Mobile and seasonally flexible primary health care and veterinary services matching the needs of specific nomadic populations should be developed, besides seasonal check post for monitoring and surveillance of health aspects at some transit points.

Table 6: Prevalence of gastrointestinal parasites in sheep and goats Himachal Pradesh

Parasites	No (%) infected*

	Sheep (n=335)	Goat (n=158)	Overall (n=493)
Flukes			
Fasciola spp.	32 (9.6)	14 (8.8)	46 (9.3)
Amphistome spp.	13 (3.8)	4 (2.5)	17 (3.4)
Dicrocoelium spp.	24 (7.2)	4 (2.5)	28 (5.7)
Schistosoma spp.	4 (1.2)	1 (0.6)	5 (1.0)
Cestodes			
Moniezia spp.	9 (2.7)	2 (1.3)	11 (2.2)
Nematodes			
Strongyle spp.	307 (91.6)	158 (100)	465 (94.3)
Strongyloides spp.	16 (4.8)	8 (5.1)	24 (4.9)
Dictyocaulus spp.	4 (1.2)	2 (1.3)	6 (1.2)
Trichuris spp.	48 (14.3)	2 (1.3)	75 (15.2)

*Total numbers and total percentage of animals exceed expected values owing to multiple parasitism

Personal hygiene, respect for good animal husbandry and health practices throughout the production, harvesting and processing of food for human consumption contributes to reducing the risk of transmission to man. Regular dog treatments, strict dog control, a prohibition on the feeding of uncooked offal to dogs and regulation of open slaughter of livestock could prevent most common zoonoses. Increase in numbers of both human and animal has also altered the ecological balance in the region. Hence role of pets, domestic and wild animals in the spread of parasitic zoonoses should be carefully considered in health planning.

The preparation of herbal medicines remains an important part of healthcare for both human and livestock, especially in rural areas in the state by the traditional migratory communities. The small and subsistence farmers in remote communities and the nomads like *Gaddis* depend largely on the use of medicinal plants based on indigenous knowledge, in the absence of veterinarians and modern veterinary medicines at high alpine Himalayan pasture land which is considered to be a museum of aromatic and medicinal plants. There is a growing need for identification and development of human and veterinary drugs based on locally available plant resources.

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