Overview of bluetongue disease, viruses, vectors, surveillance and unique features: the Indian sub-continent and adjacent regions

D. Sreenivasulu[(1)], M.V. Subba Rao[(2)], Y.N. Reddy[(3)] & G.P. Gard[(4)]

(1) Department of Microbiology, College of Veterinary Science, Tirupati 517 502 AP, India
(2) Faculty of Veterinary Science, Acharya N.G. Ranga Agricultural University, Rajendra Nagar, Hyderabad 500 030 AP, India
(3) Department of Microbiology, College of Veterinary Science, Rajendra Nagar, Hyderabad 500 030 AP, India
(4) 8 Casey Crescent, Mystery Bay, NSW 2546, Australia

Summary

The occurrence of bluetongue (BT) disease in India was initially confined to exotic breeds of sheep and subsequently became endemic in native breeds. BT virus (BTV) antibodies are common in cattle, buffaloes and goats although clinical disease has not been reported. Exotic breeds of sheep and their cross-breeds are more susceptible to disease than native breeds. Overall, morbidity, mortality and case fatality rates of 9.3%, 2.7% and 28.8%, respectively, have been reported in rural flocks; these rates are higher than in organised farms. The disease is mostly cyclical in occurrence. Outbreaks usually occur between June and December during the monsoon period when livestock biting midges greatly increase. BTVs have been isolated from native sheep, and sentinel herds have been used to demonstrate virus activity. A total of 21 serotypes of BTV have now been reported in the country. Major impediments to control the disease include the presence of multiple virus serotypes, the broad vertebrate host range of the virus and a lack of detailed knowledge of vectors. Inactivated vaccines prepared from local isolates are currently under field trials. BTV occurs in regions adjacent to India. An antibody prevalence of 48.4% has been reported in Pakistan with serotypes 3, 9, 15, 16 and 18 identified. BTV antibody, but not disease, has been reported in Bangladesh and Sri Lanka.

Keywords

Bluetongue – Bluetongue virus serotypes – Epidemiology – India – Serological surveillance – Vectors.

Bluetongue (BT) has become one of the important sheep diseases of the Indian sub-continent. The disease was first reported in Pakistan in 1959 and in India in 1964 (19). The disease has since become established in India, a geographically vast and climatically diverse country. The Indian subcontinent, a peninsula, lies between 8.4°N and 37.6°N and 68.7°E and 97.25°E. India is divided into seven climatic regions, namely: the northern mountains, the northern plains, the Rajastan Desert, the Deccan plateau, the west coast, the south-east coast lands and Assam in the extreme north-east. The Indian climate is dominated by the great wind system called the Asiatic monsoon and which reverses direction at certain times of the year. From June to October, India is influenced by the moist rain-bearing monsoon from the south-west. The coolest, driest period over most of India is from December to February. From March to May the climate becomes very hot and the drought continues. Usually, the monsoon enters the south during late May or early June, reaching the north about six weeks later. In some years, the rains are torrential, but in other years they will be only light.

India has significant populations of domestic and wild ruminants, which are known to be susceptible to BTV infection. Several exotic breeds of sheep were introduced into the country between 1960 and 1970 for the genetic improvement of the national flock by crossbreeding with native breeds. This increase in the national susceptible population, along with favourable climatic conditions, appears to have led to the establishment of BT in the country.

Epidemiology

First decade of bluetongue (1964-1974)

After the initial report of BT in Maharashtra, the disease was reported in exotic sheep, namely Southdown, Rambouillet, Russian Merino and Corriedale, between 1967 and 1970. Severe BT was also reported in the Dorset breed in Andhra Pradesh in 1974. However, the native sheep maintained in close proximity did not present any symptoms. However, the disease was subsequently recorded in native sheep and disease outbreaks have been reported annually since 1981.

Endemic phase

During 1981, BT was widely spread in southern India. Initially, the disease was detected in Karnataka and in the adjoining regions of Maharashtra and Andhra Pradesh, with mortality rates ranging from 2% to 50%. Morbidity was as high as 80%. Later, in 1983, BT outbreaks were reported all over Andhra Pradesh with a case fatality rate of 21.9%. From 1985 onwards, outbreaks were recorded regularly in Andhra Pradesh with case fatality rates ranging from 2.37% to 38.14% (Table I). A cyclical pattern of the disease was observed with variations in severity of infection.

Table I
Outbreaks of bluetongue in native sheep in Andhra Pradesh, 1985-2002

Year	Outbreaks	Cases	Deaths	Case fatality (%)
1985	311	13 093	1 652	12.61
1986	35	2 225	99	4.44
1987	101	6 609	157	2.37
1988	255	53 293	6 036	11.32
1989	112	7 959	523	6.57
1990	119	3 719	405	10.89
1991	284	19 975	1 056	5.28
1992	55	936	111	11.89
1993	168	6 475	252	3.89
1994	283	41 717	9 261	22.19
1995	71	1 179	35	2.97
1996	395	30 708	7 812	25.44
1997	21	569	217	38.14
1998	1132	146 765	27 392	18.66
1999	34	443	85	19.19
2000	240	7 591	1 028	19.54
2001	575	12 435	1 375	11.06
2002	44	596	103	17.28

Source: Animal Disease Surveillance Reports, Department of Animal Husbandry, Government of Andra Pradesh, India

The outbreaks of the disease in Maharashtra were characterised with morbidity and mortality rates of 7.66% and 1.11%, respectively. The case fatality rate was 11.82% (5). Later, an increase in the severity of infection was reported by Kulkarni *et al.* (10) with overall morbidity of 32%, mortality of 8% and a case fatality rate of 25% in rural areas. The disease was recorded regularly in Tamil Nadu where a total of 258 outbreaks were reported between 1986 and 1995. Saravanabava (20) reported morbidity ranging from 3.3% to 22.8% and mortality from 0% to 6.1%.

The pattern of disease was studied in the organised farms and rural flocks of Andhra Pradesh. The study revealed that the pattern of the disease in organised farms and rural flocks is quite different. Morbidity, mortality and case fatality rates of rural and organised farms were 9.34%, 2.69%, 28.84% and 6.22%, 0.47%, 7.63%, respectively. Higher morbidity and mortality in rural areas may be because of stress factors, such as poor nutrition, parasitic burden, fatigue due to long walks and absence of veterinary aid. Investigations in Andhra Pradesh revealed that sheep aged 6 to 12 months were more susceptible than adults. The disease has not been reported in lambs. Similar observations were also reported from Maharashtra and Haryana (5, 25).

The occurrence of BT varies between parts of India depending on time of rainfall. Maximum numbers of outbreaks were recorded during the north-east monsoon period (October to December) followed by the south-west monsoon period (June to September) in Andhra Pradesh (Table II). Similarly, in Tamil Nadu the outbreaks were more frequent during the north-east monsoon period (20). In Rajasthan, the outbreaks occurred mostly in September and November (12).

Clinical disease

During the initial outbreaks in the country, all exotic sheep breeds imported into India (Merino, Rambouillet, Corriedale, Dorset and Suffolk) exhibited classical signs of BT. Similar clinical observations of less intensity were noticed in cross-bred sheep. However, clinical disease was slightly different in native sheep, the major difference being that swelling of the lips and face was less conspicuous. Mucocutaneous borders appeared to be very sensitive to touch and to bleed easily upon handling. The classical signs of cyanosis of the tongue and reddening of the coronary band are not a common feature of the disease in native sheep. Clinical disease has not been reported in cattle, buffalo and goats in spite of high seroprevalence. Clinical disease is known to occur in Pakistan.

Table II
Seasonal occurrence and number of outbreaks of bluetongue in Andhra Pradesh, 1989-2001

Year	Rainfall in mm*				No. of outbreaks **			
	South-west monsoons (June-Sep)	North-east monsoons (Oct-Dec)	Winter period (Jan-Feb)	Hot weather period (Mar-May)	South-west monsoons (June-Sep)	North-east monsoons (Oct-Dec)	Winter period (Jan-Feb)	Hot weather period (Mar-May)
1989-1990	896	88	37	322	98	14	0	0
1990-1991	647	283	11	41	45	74	0	0
1991-1992	696	243	7	35	282	0	1	1
1992-1993	555	221	0	61	28	20	5	2
1993-1994	511	242	15	49	67	96	4	1
1994-1995	485	324	46	163	279	3	1	0
1995-1996	627	303	1	40	8	63	0	0
1996-1997	737	279	19	75	171	224	0	0
1997-1998	520	233	14	48	9	8	2	2
1998-1999	755	300	3	70	225	906	1	0
1999-2000	534	135	36	65	27	5	2	0
2000-2001	759	91	3	72	66	170	4	0
Total					1 305	1 583	20	6

* *Source*: Statistical Abstracts, Directorate of Economics and Statistics, Government of Andra Pradesh, India

** *Source*: Animal Disease Surveillance Reports, Department of Animal Husbandry, Government of Andra Pradesh, India

However, the disease has not been reported from Bangladesh, Myanmar and Sri Lanka (OIE, Annual Report, 2003).

Serosurveillance

Extensive serological surveys have been undertaken in different parts of the country. Studies conducted in Andhra Pradesh during 1991 revealed a higher prevalence of BT virus (BTV) antibodies in sheep and goats (45.71% and 43.56%, respectively) than in cattle (33.4%) and buffalo (20%). This higher prevalence in small ruminants may reflect their involvement in the basic ecology of the virus. Similar observations were made by Sharma *et al.* (21) and Prasad *et al.* (17) in Rajasthan and Haryana. Harbola *et al.* (5) reported BTV antibodies in 37.5% of sheep serum samples collected from Maharashtra State. Others have reported the seroprevalence of BTV antibodies from Gujarat, Maharashtra, Madhya Pradesh, West Bengal and Tamil Nadu (9, 14). Sodhi *et al.* (22) reported a seroprevalence of 6.64% in Punjab State with a higher prevalence in exotic breeds than in indigenous sheep. Bandopadhyay and Mullick (2) made similar observations. A seroprevalence of 13.76% and 7.10% was recorded in sheep and goats in Kerala State, though clinical disease was not noted (18).

The investigations of the authors have demonstrated BTV antibodies in 23% of native cattle and 71.9% of exotic cattle in Andhra Pradesh. Oberoi *et al.* (16) reported BTV antibodies in 37.5% of buffalo and 70% of cattle sera in Punjab. In Gujarat, 13.4% of buffalo and 15.6% cattle sera were positive for BTV antibodies (24). Jain *et al.* (8) noted the incidence of BTV antibodies as higher in buffalo (10.6%) than in cattle (4.2%). Mehrotra and Shukla (14) tested cattle sera from Andhra Pradesh, Karnataka, Gujarat, Punjab, Orissa, Himachal Pradesh and West Bengal and reported 18% BTV antibody positive. Prasad *et al.* (17) performed a serological survey in Rajasthan and Haryana and reported that 33.33% goat sera were positive for BTV antibodies. These reports established the fact that BTV infection is present in cattle, buffalo and goats in India.

Vectors

Culicoides insects are the vectors of BTV. Of over 1 400 species present worldwide, at least 39 have been reported to occur in India. Very few species of *Culicoides* have been demonstrated to be vectors for BTV, with the principal vectors varying geographically. Midges collected from Harayana, Punjab, Rajasthan and Himachal Pradesh were identified as *C. oxystoma* (3). Jain *et al.* (7) isolated BTV from midges, but vector speciation was not performed. *C. imicola* and *C. oxystoma* were found to be prevalent in Tamil Nadu. Details of vector species responsible for transmission of BTV in India are lacking. Virus-vector relationships also need to be analysed critically.

Virus isolation

Of the 24 serotypes of bluetongue viruses recognised internationally, 21 have been reported from India. Eleven of these serotypes were identified after virus isolation while 10 serotypes were presumed present, based on serology. BTV serotypes 3, 9, 15, 16 and 18 have been reported from sheep flocks of Pakistan (1).

Reports on isolation of BTV from India commenced with Kulkarni and Kulkarni (11) in 1984 who isolated BTV serotypes 9 and 18. Jain *et al.* (6) later reported type 1, employing chicken embryos and BHK-21 cell cultures for virus isolation. Mehrotra *et al.* (13, 15) recovered BTV serotypes 3, 9, 16, 18 and 23 from sheep from Madhya Pradesh, Maharashtra, Tamil Nadu, Uttar Pradesh and Jammu and Kashmir. BTV-2 was reported by Sreenivasulu *et al.* (23) from sheep outbreaks in Andhra Pradesh. Deshmukh and Gujar (4) isolated BTV serotype 1 from Maharashtra. Table III summarises the detection of BTV serotypes in different Indian states.

Table III
Distribution of bluetongue serotypes in India

State	Species	Virus isolation	Serotype antibodies
Tamil Nadu	Sheep	3, 16, 23	1, 4-7, 11, 12, 14-17, 19, 20
Andhra Pradesh	Sheep	2	4, 12-14, 17-19
	Cattle	–	6, 12
Karnataka	Sheep	23	1, 2, 12, 16, 17, 20
	Cattle	–	1, 14, 16
Maharashtra	Sheep	1, 2-4, 8, 9, 16, 18	–
Gujarat	Buffalo	–	1, 15, 17
	Cattle	–	2, 12, 20
Madhya Pradesh	Sheep	18	–
Uttar Pradesh	Sheep	9, 18, 23	–
Haryana	Sheep	1, 4	14
	Cattle	–	1, 2, 8, 12, 16
Himachal Pradesh	Sheep	3, 9, 16, 17	4
Jammu and Kashmir	Sheep	18	–

Sentinel studies

In 1993, sentinels were used to follow the circulation of BTV serotype 12 in Andhra Pradesh. Seroconversion was recorded in September and was associated with rainfall and increased *Culicoides* populations. Similarly, active circulation of BTV was detected in Himachal Pradesh, Punjab and Rajasthan between June and November (17).

Vaccines

It is evident that multiple BTV serotypes are circulating in this region and virulence characteristics need to be studied to identify the pathogenic serotypes. Most BTV serotypes have been reported from Maharashtra, Gujarat, Andhra Pradesh, Tamil Nadu and Harayana. However, data is incomplete because systematic studies have not been undertaken to elucidate the prevalence of serotypes in different states. In view of this, the Indian Council of Agricultural Research has considered it necessary to map the BTV serotypes circulating in different Indian states with a long-term objective of the production of suitable vaccines. Research was initiated in seven states where BT is prevalent, whilst work on BTV vaccines incorporating endemic serotypes has commenced. Accordingly, a hydroxyl amine inactivated BTV-2 vaccine has been developed and is presently under field evaluation.

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