

# Seroepidemiology of peste des petits ruminants in sheep and goats of southern peninsular India

A.G. Raghavendra<sup>(1)</sup>, M.R. Gajendragad<sup>(2)\*</sup>, P.P. Sengupta<sup>(2)</sup>, S.S. Patil<sup>(2)</sup>, C.B. Tiwari<sup>(2)</sup>, M. Balumahendiran<sup>(2)</sup>, V. Sankri<sup>(2)</sup> & K. Prabhudas<sup>(2)</sup>

(1) Department of Diagnostic Medicine / Pathobiology, # 308, Coles Hall, KSUCVM, Kansas State University, Manhattan, Kansas 66506-5606, United States of America

(2) Project Directorate on Animal Disease Monitoring and Surveillance, Indian Council of Agricultural Research, Indian Veterinary Research Institute Campus, Hebbal, Bangalore 560024, Karnataka, India

\*Corresponding author: E-mail: gajendragad@gmail.com

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## Summary

This paper presents the results of a seroepidemiological study carried out between July 2006 and March 2007 to detect the presence of antibodies to peste des petits ruminants (PPR) virus in randomly collected serum samples from sheep and goats in southern peninsular India. The authors used a competitive enzyme-linked immunosorbent assay with a monoclonal antibody developed against a neutralising epitope of the haemagglutinin (HA) protein of the virus. A total of 1,492 sheep sera and 2,068 goat sera collected from the six southern Indian states were screened. It was determined that 41.35% of the sheep sera and 34.91% of the goat sera were positive for the presence of antibody. The study indicated an extensive endemicity of the disease in these states, which is attributed to the agro-climatic conditions and the migration of livestock.

## Keywords

Competitive enzyme-linked immunosorbent assay – Indian peninsula – Peste des petits ruminants – Seroepidemiology.

## Introduction

Peste des petits ruminants (PPR) is an acute febrile viral disease of goats and sheep that is characterised by fever, mucopurulent nasal and ocular discharges, conjunctivitis, necrotising and erosive stomatitis, enteritis and pneumonia (12). It is one of the major notifiable diseases of the World Organisation for Animal Health (OIE). It has a widespread distribution across sub-Saharan Africa, the Middle East and Southern Asia (5). The disease is endemic in India and causes large economic losses each year as a result of the high rates of mortality and morbidity in infected sheep and goats. The PPR virus is an enveloped ribonucleic acid virus that belongs to the genus *Morbillivirus* and family *Paramyxoviridae* (8). The virus is sensitive to environmental changes. Rapid inactivation of the virus will

occur when it is exposed to conditions outside the host. Consequently, close contact between infected and susceptible animals is necessary for disease transmission to take place (5, 17).

The disease has been reported from various parts of Asia and Africa (6, 22). Although PPR is believed to have been present in southern India prior to the late 1980s (32), the disease was not reported in the region until 1987 (24). Since then PPR outbreaks have been reported regularly from all parts of the country (15, 16, 18, 19, 20, 31), and the disease is considered to be endemic throughout India (27).

India has a considerable sheep population of 62.5 million and a goat population of 123 million, which stand third

and second respectively in the world ranking (21, 29). The ratio of goats to sheep and the population intensity vary greatly under different agro-climatic conditions. Sixty-one percent of the total sheep population and 25% of the goat population are located in southern peninsular India. In India, sheep and goats play an important role in sustainable agriculture and generation of employment (3, 10). The annual production of mutton in India during 2004 was almost 7 million tonnes (7). Annual production of 30 million pieces of sheep skin and 82 million pieces of goat skin was also registered in 2004/2005 and this excludes a considerable amount of fleece and wool production every year (4). Thus, sheep and goat husbandry contribute a substantial amount to the Indian economy. The annual economic losses attributable to peste des petits ruminants virus (PPRV) have been estimated to be Rs. 180 million (US\$3 million) (2). A mortality rate of 50% or more in susceptible sheep and goats that are infected with PPR has been reported (1, 15, 25). Sheep and goat husbandry is primarily the work of small to marginal farmers and labourers who do not possess land (23). In view of the economic importance of the disease and the dense sheep and goat population in the region, a study of the seroprevalence of PPR in southern peninsular India was performed.

## Materials and methods

### Serum sample collection

Serum samples were collected from a random sample of sheep and goats by the scientists of the Project Directorate on Animal Disease Monitoring And Surveillance (PD-ADMAS) and field veterinary staff. A total of

3,560 serum samples were collected from the six states of southern India (Table I).

### Competitive enzyme-linked immunosorbent assay

All the serum samples tested in the present study were processed in duplicate following a standard protocol (28). The serum samples were assayed for the presence of antibodies to PPRV by competitive enzyme-linked immunosorbent assay (ELISA) using a kit developed at the Indian Veterinary Research Institute, Mukteshwar-Kumaon, Uttaranchal, India. The competitive ELISA (c-ELISA) test is based on inhibition of the binding of monoclonal antibody to antigen in the presence of PPR antibody in the field sera. A monoclonal antibody (MAb) designated 4B11 that is directed against a neutralising epitope of the haemagglutinin (HA) protein of PPRV is employed in the kit.

The results were interpreted using the software developed by the Food and Agriculture Organization (FAO) and the International Atomic Energy Agency (IAEA) for the detection of rinderpest antibody (11, 14). Samples with percentage inhibition of  $\geq 50\%$ , compared with wells containing the MAb control, were considered positive. A 95% confidence interval (CI) for the prevalence of antibodies to PPRV in the population studied was calculated using standard statistical methods (13).

### Statistical analysis

Differences in the estimated prevalence between animal species and states were analysed statistically using the chi square test ( $\chi^2$ ) for independence (30).

**Table I**  
**Details of the serum samples screened from various states of southern peninsular India**

State	Sheep			Goats		
	Screened	Positive	% Positive	Screened	Positive	% Positive
Andhra Pradesh	221	83	37.56 <sup>(a)</sup>	361	124	34.34 <sup>(a, c)</sup>
Goa	118	49	41.52 <sup>(a)</sup>	186	71	38.17 <sup>(a, b)</sup>
Karnataka	552	290	52.53 <sup>(b)</sup>	734	213	29.02 <sup>(c)</sup>
Kerala	113	47	41.59 <sup>(a)</sup>	205	98	47.80 <sup>(b)</sup>
Maharashtra	299	87	29.09 <sup>(c)</sup>	290	107	36.90 <sup>(a)</sup>
Tamil Nadu	189	61	32.27 <sup>(a, c)</sup>	292	109	37.33 <sup>(a)</sup>
<b>Total</b>	<b>1,492</b>	<b>617</b>	<b>41.35</b>	<b>2,068</b>	<b>722</b>	<b>34.91</b>
<b>95% CI</b>		<b>40.36% to 42.33%</b>			<b>34.21% to 35.61%</b>	

$\chi^2$  Sheep between states = 54.72\*\* (d.f.5) ( $p < 0.01$ )

$\chi^2$  Goats between states = 28.38\*\* (d.f.5) ( $p < 0.01$ )

$\chi^2$  Seroprevalence between sheep and goats = 15.32\*\* (d.f.1) ( $p < 0.01$ )

a, b, c: prevalence values in the same species with the same superscript do not differ significantly ( $p > 0.05$ )

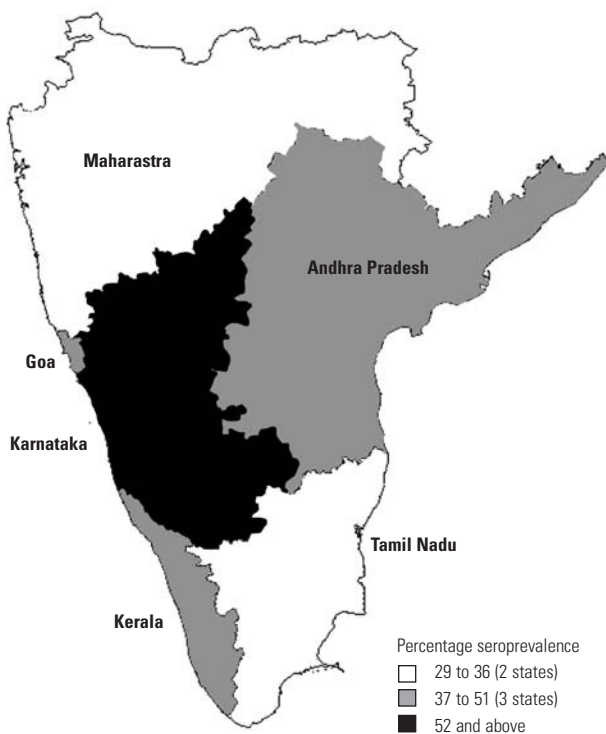
## Results

A total of 1,492 serum samples from sheep and 2,068 from goats were screened for PPRV antibodies using the monoclonal based c-ELISA. The presence of antibody was detected in 41.35% of sheep sera and 34.91% of goat serum samples (Table I).

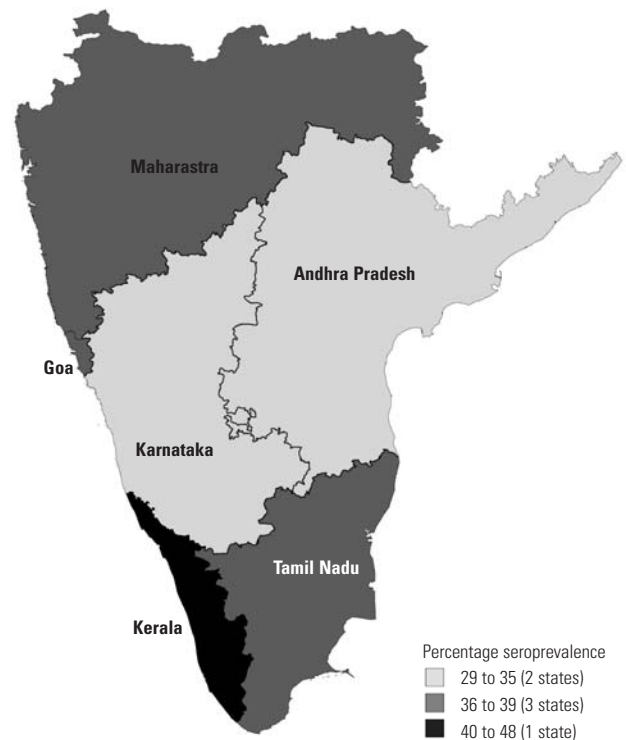
Statistically significant variation was observed when the seroprevalence in both sheep and goats was compared across the different states ( $p < 0.01$ ). The sheep serum samples from Karnataka ( $n = 552$ ) showed the highest seroprevalence (52.53%), whereas Maharashtra ( $n = 299$ ) recorded the lowest (29.09%), and Tamil Nadu ( $n = 189$ ) showed a seroprevalence of 32.27%. Although the number of samples screened from the states of Kerala ( $n = 113$ ) and Goa ( $n = 118$ ) was lower, a substantial proportion were positive for the antibody (approximately 42% in each case), which is close to the combined average of 41.35% (95% CI: 40.36% to 42.33%) (Table I), indicating the uniform spread of the disease. The prevalence of PPR in sheep is related to the sheep population in the region (Fig. 1).

Among the goat serum samples screened from the six states, Kerala ( $n = 205$ ) showed the highest seroprevalence, 47.8%, followed by Goa ( $n = 186$ ) with 38.17%. In contrast, the seroprevalence in the other states, such as Tamil Nadu ( $n = 292$ ), Maharashtra ( $n = 290$ ), Andhra Pradesh ( $n = 361$ ) and Karnataka ( $n = 734$ ) was 37.33%, 36.90%, 34.34% and 29.02% respectively, close to the combined average of 34.91% (95% CI: 34.21% to 35.61%). Statistically significant variation was also observed with respect to the seroprevalence in goats among the different states selected for the present study ( $p < 0.01$ ). The prevalence of PPR in goats is related to the goat population in the region (Fig. 2).

Andhra Pradesh and Karnataka, which have the highest sheep and goat populations among the states, also had the highest seroprevalence. Although the sheep population in Kerala is very small, the presence of antibodies in the animals from this state suggests that sheep are particularly susceptible to the disease. This hypothesis is further supported by the results of the goat serosurvey: in spite of the high goat population in these two states the seroprevalence was low.



**Fig. 1**  
Map showing the distribution of levels of seroprevalence of peste des petits ruminants virus in sheep in the six states of southern peninsular India



**Fig. 2**  
Map showing the distribution of levels of seroprevalence of peste des petits ruminants virus in goats in the six states of southern peninsular India

## Discussion and conclusion

The higher prevalence of antibodies to PPRV in the sheep as compared with the goat population should be interpreted as demonstrating an increased susceptibility of sheep to infection with PPR. This may be attributed to a higher recovery rate (lower case fatality rate) and/or a greater longevity of sheep compared with goats. Male goats are sold for meat at the local market at approximately one year of age (the age at which the desired body weight is reached), but sheep, which are used for production of both wool and meat, are kept for a longer period of time. Recovered (convalescent) animals will have detectable levels of circulating antibody in their serum. The presence of a large proportion of animals in the sheep population that have recovered from previous infections with PPRV and are maintained in the flock over many years for the purpose of wool production may indirectly account for the high prevalence of antibodies to PPRV detected in sheep (41.35%) compared with that in goats (34.91%) (26).

The results of the present study suggest that sheep are more susceptible to PPR than goats, which is in agreement with earlier reports (24, 28). However, Soundararajan *et al.* (31) reported a higher mortality in infected goats than in sheep. Their study was carried out on an 'organised' farm (i.e. a large farm) that was probably suffering an outbreak, whereas the present study was performed in rural areas, in a sector that is less well organised. This could be the major reason for the higher prevalence of disease in sheep in this study, as exemplified by the comparatively higher seroprevalence in Kerala and Goa. The consistent presence of antibody in both sheep and goats indicates the widespread endemicity of the disease, which is in agreement with the views of earlier authors (31).

The majority (78.2%) of farmers in India have small and marginal land holdings (9). In general, small ruminants are farmed in a free-range manner on land that includes pasture, shrubs and forest cover. As a result of an ongoing decrease in the available pasture land and forest area, these animals travel long distances during the dry season in

search of fodder and water. In southern India, sheep and goats are reared mostly by nomads and there is extensive migration of these animals. As the summer progresses these animals migrate in search of pasture and for trade purposes and may return during the monsoon. The mutton market is concentrated in states such as Kerala, Goa, Tamil Nadu and Maharashtra, which may explain the higher incidence of PPR in these states.

In India the ratio of goats to sheep is approximately 2:1. In the present study, despite the small sample size, the ratio of goats to sheep was also approximately 2:1 (26). Although the sample in this study was limited and may not be a true representation of the target population, it has provided preliminary information on PPRV infection in southern India.

Earlier workers (28) have recorded an average prevalence of PPR of 33% in southern Indian states, and were of the opinion that the PPRV has a higher affinity for goats than sheep. In contrast, the present study indicates that sheep are more susceptible than goats, as the authors recorded a higher prevalence of antibodies in sheep than in goats, despite the fact that the study area included all the states of southern India, including Kerala, all of which have higher goat populations. Furthermore, this study has presented the seroprevalence of PPR among sheep and goats reared by farmers who are below the poverty line and whose livelihood is totally based on rearing sheep or goats; these sheep and goats are maintained on pasture grazing and receive minimal veterinary care, which may increase the possibility of the animals acquiring the infection.

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## Séroépidémiologie de la peste des petits ruminants chez les ovins et les caprins dans le sud de la péninsule indienne

A.G. Raghavendra, M.R. Gajendragad, P.P. Sengupta, S.S. Patil, C.B. Tiwari, M. Balumahendiran, V. Sankri & K. Prabhudas

### Résumé

Les auteurs présentent les résultats d'une étude séroépidémiologique visant à détecter la présence d'anticorps vis-à-vis du virus de la peste des petits ruminants (PPR) dans un échantillon aléatoire de sérums ovins et caprins collectés dans le sud de la péninsule indienne. Les sérums ont été soumis à l'épreuve immuno-enzymatique de compétition utilisant un anticorps monoclonal dirigé contre un épitope neutralisant de l'hémagglutinine (HA) virale. Au total, 1 492 sérums ovins et 2 068 sérums caprins prélevés dans les six états méridionaux de l'Inde ont été analysés. La présence d'anticorps a été détectée dans 41,35 % des sérums ovins et 34,91 % des sérums caprins. L'étude a révélé que la maladie est fortement endémique dans ces états, ce qui s'explique par les conditions agro-climatiques ainsi que par les migrations auxquelles le bétail est soumis.

### Mots-clés

Épreuve immuno-enzymatique de compétition – Péninsule indienne – Peste des petits ruminants – Séroépidémiologie.



## Seroepidemiología de la peste de pequeños rumiantes en ovejas y cabras del sur de la India peninsular

A.G. Raghavendra, M.R. Gajendragad, P.P. Sengupta, S.S. Patil, C.B. Tiwari, M. Balumahendiran, V. Sankri & K. Prabhudas

### Resumen

Los autores presentan los resultados de un estudio seroepidemiológico destinado a detectar la presencia de anticuerpos contra el virus de la peste de pequeños rumiantes (PPR) en muestras de suero de oveja y cabra extraídas de forma aleatoria en el sur de la India peninsular. Los autores utilizaron un ensayo inmunoenzimático (ELISA) de competición con un anticuerpo monoclonal dirigido contra un epitopo neutralizante de la hemagglutina (HA) del virus. Tras el análisis de un total de 1.492 muestras de suero de oveja y 2.068 muestras de suero de cabra obtenidas en los seis estados meridionales de la India, resultaron positivos a la presencia del anticuerpo un 41,35% de los sueros ovinos y un 34,91% de los caprinos. Del estudio se infiere que en los susodichos estados hay una endemicidad muy extendida de la enfermedad, cosa que se atribuye a las condiciones agroclimáticas y a las migraciones de ganado.

### Palabras clave

Ensayo inmunoenzimático de competición – Península india – Peste de pequeños rumiantes – Seroepidemiología.



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