TABLE 1: Subgroups of lyssavirus

Virus	Serotype	Genotype	Geographical origin	Original host	Secondary host
Rabies virus	1	1	Worldwide, except eg: Scandinavia, Iceland, UK, Ireland, Australia, New Zealand	Dog, cat, fox, skunk, raccoons, mongoose, bat (Americas)	Mammals, man
Lagos bat virus	2	2	Nigeria and other African countries	Bat (frugivorous)	Cat, dog
Mokola virus	3	3	Nigeria and other African countries	Shrews, rodents	Cat, dog, man
Duvenhage bat virus	4	4	South Africa, Zimbabwe	Bat (insectivorous)	Man (South Africa 1971)
European bat lyssavirus 1a (EBL-1a)	?	5	Denmark, Germany, Netherlands, Poland, Russia	Bat (insectivorous)	Man (Russia 1985)
European bat lyssavirus 1b (EBL-1b)	?	5	Netherlands, France, Spain	Bat (insectivorous)	
European bat lyssavirus 2a (EBL-2a)	?	6	Netherlands, UK	Bat (insectivorous)	
European bat lyssavirus 2b (EBL-2b)	?	6	Finland, Switzerland	Bat (insectivorous)	Man (Finland 1986)
Australian bat lyssavirus	?	?	Australia	Bat (frugivorous and insectivorous)	Man (Australia 1997)

showed a weak positive rabies staining reaction. This was an atypical behaviour compared with a reference EBL-1a strain from rabies postive *E serotinus* bats which was injected into control mice, all of which died between day 6 and 25 showing a strong and widely disseminated rabies specific fluorescence staining on brain smears. Negative controls, injected with brain material from non-rabies suspected bats, were killed one to two months later and showed no rabies specific immunofluorescence staining reaction. However, the rabies diagnosis was finally confirmed by nucleotide sequence analysis at the Institut Pasteur though in only two of nine bats suspected of having rabies. The strain was again classified as an EBL-1a subgenotype. Consequently the remaining animals in the Dutch colony were also destroyed.

A similar clinical rabies outbreak has previously been experienced in a Danish closed laboratory bat colony (*Eptesicus fuscus*), newly imported from the USA, in which 50 per cent of the animals died, starting three to four weeks after transfer (Stougaard 1994).

The finding of an EBL-1a subgenotype in the Dutch flying fox colony indicates a northern European source of the original infection (Amengual and others 1997) which was probably introduced into the colony at a point in its history. The colony concerned had been established in 1991 following the importation of animals from 12 different zoos; it had remained a closed colony since its establishment. It is possible, however, that the increased number of cases of rabies seen in free-living bats in Denmark during 1997 may have increased the likelihood of infection passing from free-living to captive bats. The present findings support the hypothesis that persistent, subclinical rabies infections are more common in bats than previously thought and that such infection may lead to clinical outbreaks of rabies following the imposition of an additional stress factor such as transport, the habitation of new dwellings or high environmental temperatures.

The possible transmission of rabies virus from bats to human beings is a matter of continued concern. The new genotype classification system of rabies viruses has demonstrated that, in addition to the African Mokola, Duvenhage, and the new demonstrated Australian (not yet genotyped) rabies related virus strains, the EBL-1a and EBL-2b strains, which are widespread in western Europe, have been isolated from a few fatal cases in man (Table 1). It is therefore suggested that the opening of any private or public bat aviary to visitors be reconsidered, unless the actual bat colony can be confirmed as rabies-free.

Bat species are protected by law. However, individual free-living or captured bats showing abnormal behaviour should, if possible, be collected with due concern for personal safety and forwarded to a diagnostic laboratory in order to exclude or subtype any rabies virus. Though the EBL types have never been demonstrated in terrestrial animals (Bourhy and others 1992, Whitby and others 1996), any injury in humans or domesticated animals caused by a bat suspected of being infected with rabies must immediately be followed by rabies postexposure prophylaxis, despite the weaker efficacy of the conventional rabies vaccine of genotype 1 against infections caused by EBL (Lafon and others 1988, Perrin and others 1991).

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First report of bovine neosporosis in dairy cattle in Costa Rica

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NEOSPOROSIS has recently been recognised as a major cause of abortion in dairy cattle worldwide (Barr and others 1990, Duff and Otter 1994, Boulton and others 1995). The disease is caused by the protozoan parasite, *Neospora caninum*, which is closely related to *Toxoplasma gondii* (Dubey and Lindsay 1993). Consequently, it may have a life cycle similar to *T gondii*, which is transmitted by ingestion of oocysts in the faeces of a definitive host or by oral or nasal exposure to tachyzoites or oral exposure to

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TABLE 1: Seropositive cows and crude odds ratio of aetiological agents related to abortion rate in Costa Rica at the time of first (at abortion) and second (21 days after abortion) sampling

	First sampling				Second sampling			
	Case	Control	OR	95 per cent CI	Case	Control	OR	95 per cent CI
Brucella	5	8	1·9	0·596-6·166	5	9	1·6	0·538-5·317
Leptospira	18	75	0·5	0·270-1·026	13	57	0·5	0·266-1·116
IBR	3	9	1·0	0·980-1·063	3	9	1·02	0·980-1·063
BVD virus	5	16	0·7	0·147-3·503	5	16	0·7	0·147-3·503
Neospora ELISA	17	6	12·1	4·43-33·91	15	6	10·0	3·64-27·89
Neospora IFAT	15	1	62·6	8-490	12	2	22·8	4-106

IBR Infectious bovine rhinotracheitis, BVD Bovine virus diarrhoea, ELISA Enzyme linked immunosorbent assay, IFAT Immunofluorescent antibody test, OR Odds ratio, CI Confidence interval for the odds ratio

bradyzoites (Thurmond and others 1997). For *N caninum*, however, vertical transmission is the major mode of transmission (Anderson and others 1997).

In Costa Rica, a retrospective study (1987 to 1993) on 23 dairy farms located in a tropical cloud forest ecosystem (Holdrige 1987) found an overall abortion rate of 7·6 per cent (515 abortions out of 6741 animals calving). Consequently, a prospective study on the same herds was planned to determine the principal aetiological agents associated with abortion. The only inclusion criterion was that the cattle were pregnant and between 60 and 260 days gestation at the beginning of the trial. A total of 570 cows from the 23 herds was selected and monitored until parturition or abortion. If a cow aborted, three controls (cows of the same herd, same gestation age and same parity) were selected. If there was more than three potential controls, the selection was made at random using a random number table. For each cow (case and controls) a blood sample for serological analysis was taken at the time of abortion and 21 days later. Serological status was assessed for leptospira (microscopic agglutination test, Wolff 1954), bovine virus diarrhoea (virus neutralisation test, OIE 1996), infectious bovine rhinotracheitis (virus neutralisation test, OIE 1996), brucellosis (Rivanol, Morilla and Bautista 1986), and neospora (immunofluorescent antibody test [IFAT], Conrad and others 1993; ELISA, Paré and others 1995). During the seven month study period a total of 49 abortions occurred, giving an incidence rate of 8·6 per cent. Twenty-two fetuses were recovered for microbiological and pathological examination. Eleven were mummified.

The study showed that only *N caninum* was associated with the risk of abortion (Table 1). At the time of the first sampling (the day of abortion), 17 cases and six controls were found positive by the ELISA. Furthermore, 15 of these cases were confirmed by the IFAT. At the time of the second sampling, 21 days after abortion, 15 cases were found to be positive by ELISA. Twelve of these were confirmed by IFAT (Table 1).

The odds ratio assessment calculated as described by Martin and others (1987) approximates the ratio between the rate of disease in exposed cows and the rate of disease in the unexposed group. Using the ELISA results as exposure factor, this showed (Table 1) that the exposed animals had a likelihood of abortion which was 12 times greater than the controls at first sampling. This figure rose to 62 times more likely using the IFAT results. At the second sampling, the odds diminished to 10 and 22 for ELISA and IFAT results, respectively. The difference between both tests can be explained by the sensitivity and specificity of the tests. Conrad and others (1993) found that titres less than or equal to 1/320 were present in all infected cows. Nevertheless, some uninfected cows infrequently had titres as high as 1/320. Thus a positive reaction at a dilution of 1/280 was used as a cut off point for the specific indication of anti-neospora antibody. This value underestimates rather than overestimates the rate of true infections.

The pathological results of the 22 recovered fetuses showed mononuclear cell infiltration with foci of necrosis on the pericardium and the mycocardium in 63 per cent of aborted fetuses. Mononuclear cell infiltration of the lungs and the liver was found in 18 per cent of fetuses. Myositis was seen in 18 per cent of the cases. Finally, necrosis of the liver, the central nervous system and muscle was observed in 36, 36 and 9 per cent of fetuses, respectively. These findings are similar to those previously reported by Barr and others (1990) and Dubey (1990).

Tissues from six aborted fetuses were sent to the California Veterinary Diagnostic Laboratory and assessed by immunohistochemical procedures (Anderson and others 1997). Immunohistochemical tests revealed one positive result for neospora antigen and one suspect positive result. On the basis of the serological, pathological and immunohistochemical results the authors conclude that neosporosis-associated abortion had occurred in these herds. To the authors' knowledge this is the first report of this condition in Costa Rica. Neosporosis has previously been detected in goats (Dubey and others 1996) and dogs (Morales and others 1995).

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THURMOND, M. C., HIETALA, S. K. & BLANCHARD, P. A. (1997) *Journal of Veterinary Diagnostic Investigation* **9**, 44

Abstract

Feline immunodeficiency virus infection: an overview

A T-LYMPHOTROPIC virus with the characteristics of a lentivirus was first described in pet cats in California in 1987. It was immediately evident that because it caused an acquired immunodeficiency syndrome it was of veterinary importance. It has many of the physical and biochemical properties of human immunodeficiency virus (HIV) and was therefore named feline immunodeficiency virus (FIV). This review considers recent knowledge of its aetiology, epidemiology, pathogenesis, clinical signs, diagnosis, prevention and treatment.

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