Neospora caninum and environmental risk factors: use of Geographical Information Systems and Remote Sensing

Laura Rinaldi and Giuseppe Cringoli

Settore di Parassitologia e Malattie Parassitarie, Dipartimento di Patologia e Sanita Animale, Universita degli Studi di Napoli "Federico II" – *CREMOPAR* Regione Campania, Napoli, Italy

Abstract

The concept that location can influence health is a very old one in medicine. As far back as the time of Hippocrates (460-377 BC), it was observed that certain diseases tend to occur in some places and not in others. Disease mapping and environmental risk assessment using digital geospatial data resources are now established as basic tools in the analysis of both human and veterinary health. Geographical Information Systems (GIS), Remote Sensing (RS) and Spatial Analysis (SA) are finding increasing use in study of geographical epidemiology and their recent application to medical and veterinary parasitology is rapidly advancing. They provide a comprehensive way to map and monitor disease and to develop models that can be used to predict changes in disease patterns associated with natural and man-made environmental changes. In addition, the use of GIS, RS and SA allows determination of risk factors and delimitation of areas at risk, permitting more rational allocation of resources for cost-effective control (Cringoli et al. 2005).

In southern continental Italy, the occurrence of antibodies to *Neospora caninum* has been reported in dogs (Cringoli et al. 1996a,b; 2002), in cattle (Guarino et al. 1998, Otranto et al. 2003) and in water buffaloes (Guarino et al. 2000), along with high seroprevalence. This demonstrates the wide diffusion of *N. caninum* in this area; and hence, a study of environmental significant factors that influence the distribution of *N. caninum* in this area, such as climate, environment could prove fruitful to better know the epidemiology of bovine neosporosis.

In an our recent study, GIS and RS were used to identify environmental and climatic features that influence the distribution of *N. caninum* utilizing data from a dedicated survey. A GIS was constructed using RS and landscape feature data together with *N. caninum* serological survey records from 81 georeferenced bovine farms with animals pastured in well-defined hilly area with Mediterranean climate. The GIS for the study area was constructed utilizing the following environmental variables: autumn-winter, spring and summer NDVI (obtained from Landsat-5 TM images, spatial resolution = 30mx30m – using the sinusoidal model for NDVI annual profile proposed by Taddei 1996 – combined in a pheno-climatic map), land cover (obtained from the Corine Land Cover map, 1:100,000), elevation, slope and aspect (obtained from a Digital Elevation Model, spatial resolution = 100 m), mean rainfall and minimum, mean, and maximum temperature in spring, summer, autumn and winter (obtained by the kriging function of GIS interpolating data from 8 local meteorological stations spanning a period of 3 years). Data on each of these features were then extracted for buffer zones consisting of the area included in a circle of 3 km diameter centered on the 81 geo-referenced centroids of the main cattle pastures. Climatic and environmental data obtained from RS and GIS (autumn-winter, spring and summer NDVI, land cover, elevation, slope, aspect, mean rainfall and minimum, mean, and maximum temperature in spring, summer, autumn and winter) and farm management and individual animal data (age, production, parturition, origin, number of cattle on farm, number of dogs on farm, pasturing length) obtained from a questionnaire were analyzed in relation to *N. caninum* seropositivity and

antibody titres. Binary logistic regression was performed to determine the most important risk factors for *N. caninum* seropositivity using the *N. caninum* serological status as a dependent variable (positive/negative). In addition, a linear regression model was used to evaluate the correlation between *N. caninum* antibody titres and the climatic, environmental, farm management and individual animal data.

With respect to individual animal risk factors, adults and heifers/steers showed higher seroprevalence to *N. caninum* than calves. This result may be explained by the increase of horizontal postnatal oocyst infection with age described by Wouda et al. (1999) and Dijkstra et al. (2001) in cattle, and by Guarino et al. (2000) in buffaloes.

With respect to farm management risk factors, cattle raised on farms having a large number of dogs showed higher seroprevalence than cattle raised on farms having a small number of dogs. Other studies performed in Spain, France, the Netherlands, Germany and Italy have also found positive associations between the seropositivity to *N. caninum* in cattle and the presence (Ould-Amrouche et al. 1999), or number (Bartels et al. 1999, Mainar-Jaime et al. 1999, Otranto et al. 2003), or density (Schares et al. 2003) of dogs on farms.

With respect to climatic factors, the high minimum temperature in spring was a risk factor, i.e., the higher the minimum temperature, the higher the prevalence of cattle seropositive to *N. caninum*. The sporulation of *N. caninum* oocysts is temperature-dependent (Gondim et al. 2002) and other recent studies have confirmed the relationship between *N. caninum* prevalence and temperature (Wouda et al. 1999; Schares et al. 2002, 2003). With respect to environmental factors, cattle pasturing in buffer zones with high values of summer NDVI showed a low *N. caninum* seroprevalence. The buffer zones in the present study that showed high values of summer NDVI usually contained forests of broadleaved trees which precluded the sun radiation and shortened the period of availibility of sporulated oocysts on the pasture.

The results of this study showed that RS and GIS data can be useful to understand the spatial pattern of a non-vector borne disease, such as neosporosis. These findings showed that climatic and environmental factors (temperature and NDVI) influence the *N. caninum* distribution in pastured cattle. This approach may be fruitful to better understand the epidemiology of bovine neosporosis; in fact the above environmental and climatic risk factors, together with the farm management and individual risk factors (age of animals and number of dogs on farm), indicate that horizontal infection resulting from the ingestion of oocysts shed by dogs is the most probable route of *N. caninum* infection in pastured cattle of Mediterranean areas. For the non-vector transmitted diseases, such as neosporosis, GIS and RS thus may be used to find ecological conditions contributing to their survival and dispersion in the environment.

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