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Geographic information systems: a useful tool to approach African swine fever surveillance management of wild pig populations

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Summary

The epidemiological surveillance of African swine fever in wild pig populations requires the previous collection of numerous samples of biological materials for virological and serological testing from each animal that has been killed during the hunting season. The number of samples needs to demonstrate the absence of the disease at a prevalence level of 5% (and confidence level of 95%) in the area subject observed. Since the typology of the territory suitable for maintaining wild pig populations and the precise location can be identified, it is possible to pinpoint specific areas within Sardinia where organised sampling is undertaken. The results from tests are used to estimate the prevalence of the disease in the wild pig population in the place of origin. Areas were identified using the geographic information system technology with support from maps in the field. The correct localisation of seropositivity has led to the redefinition of high-risk areas for African swine fever. Results from the outbreaks and the surveillance of the wild pig population has confirmed the decreasing role of the wild boar in maintaining the disease.

Keywords

African swine fever, Epidemiology, Geographic information system, Italy, Land use map, Sardinia, Surveillance, Wild boar.

I GIS: utili strumenti di gestione per un approccio corretto nella sorveglianza epidemiologica della peste suina africana nelle popolazioni suine selvatiche

Riassunto

La sorveglianza epidemiologica della peste suina africana nelle popolazioni selvatiche si basa sulla raccolta di campioni biologici per i test virologici e sierologici dagli animali abbattuti durante la stagione venatoria. Il numero di campioni deve essere in grado di dimostrare l'assenza della malattia al livello del 5%, e al 95% di confidenza, nell'areale di riferimento. Poiché è possibile individuare precisamente il tipo di territorio in grado di sostenere le popolazioni suine selvatiche, sono stati individuati specifici areali nei quali organizzare il campionamento. Il risultato dei test effettuati è utile per stimare la prevalenza dell'infezione nella popolazione selvatica dell'areale di provenienza dei campioni. Gli areali sono stati identificati con l'ausilio di un sistema GIS e di carte

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dell'uso del suolo. La corretta localizzazione dei sieropositivi è utile per la ridefinizione dell'area ad alto rischio per peste suina africana. La comparazione dei focolai e della sorveglianza epidemiologica nelle popolazioni selvatiche ha confermato il diminuito ruolo del cinghiale nel mantenimento della malattia.

Parole chiave

Cinghiali, Epidemiologia, Italia, Mappe dell'uso del suolo, Peste suina Africana, Sardegna, Sistema informativo geografico, Sorveglianza.

Introduction

The geophysical and vegetation characteristics of a large area of Sardinia create very favourable environmental conditions for the maintenance of major groups of wild boar metapopulations. These animals have a constant and adequate supply of food which results in high densities of these animals. Available literature and results of investigations performed in certain areas of Sardinia show that in extreme climatic conditions (temperature and water supply) and in the absence of forest fires which could change the home range, the density of wild boars fluctuates between two to six adults per square kilometre (3). Hunting, practised according to the local tradition, reduces the population by roughly 45% every year (2).

Materials and methods

As wild pigs consume an abundance of plant matter including acorns (in plentiful supply in broad-leaved forests), roots and tubers, it was possible to accurately locate the most suitable breeding sites with the aid of land use maps processed from Corine Land Cover 2003 developed by Geostudi snc (created using Mapinfo® geographic information systems [GIS] software used by the Regional Veterinary Epidemiology Observatory). These sites that combined the presence of water (puddles, mud) and other well-defined elements in terms of habitat, form micro-areas suitable for sustaining wild pig populations. To identify these micro-areas we considered fruit-bearing chestnut woods, agroforestry areas in general, broad-leaved and mixed conifer/broad-leaved woods, Mediterranean bush and cork oak plantations. These micro-areas (Fig. 1) which cover a total of approximately 9 060 km², were grouped into macro-areas (Fig. 2) that extended over approximately 16 827 km² and were sufficiently distant from similar areas, which made it possible to identify specific habitats inhabited by wild pig meta-populations. Using this procedure, we were able to apply the general epidemiological surveillance rules that apply to African swine fever (ASF) and classical swine fever (hog cholera) in Sardinia. A total of 32 macro-areas (ranging from 60 km² to 647 km²) were each inhabited by 400-1 000 wild boars. The main regulatory reference document to which this procedure refers is European Community Decision 2003/422/EC, which approves a diagnostic manual for African swine fever (Chapter H) (1). The use of GIS made it possible to analyse land use and then define the macro-areas in which epidemiological surveillance could be conducted on wild boar populations during the 2005-2006 hunting season. Thematic maps representing these areas were distributed to state veterinary services in Sardinia to coordinate activities of wild boar hunting groups. The hunting groups arranged for blood samples and organs removed from the dead animals to be despatched to the Experimental Zooprophylactic Institute of Sardinia.

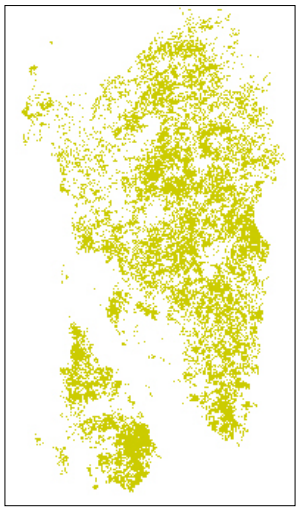

Figure 1
Wild pig population: micro-areas of Sardinia

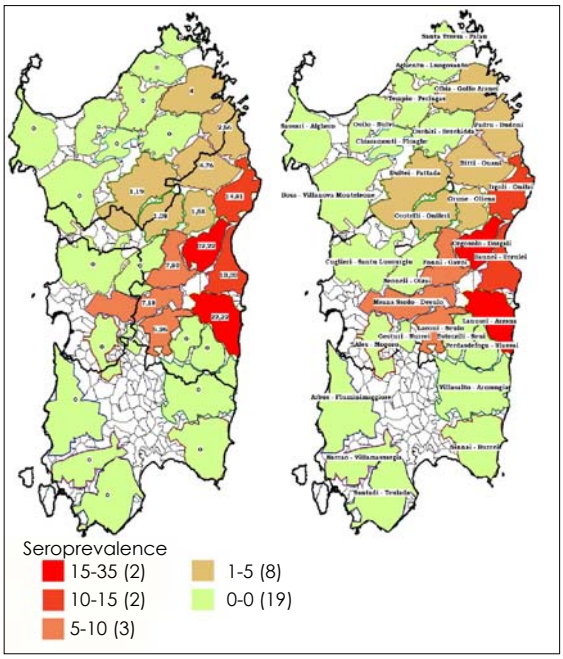

Figure 2
Wild pig population: macro-areas of Sardinia

Results

Regions of Sardinia have been classified into three large categories, according to risk, based on the combination of the three following factors:

- precise location, on micro-area basis, of ASF-seropositive wild boar that had been tested by immunoblotting
- surveillance of areas which were considered to be the source of infection for ASF between 2004 and 2005) (6, 7, 8)
- surveillance of areas which were considered to be the source of infection for ASF before 2004 (4).

This classification (Tables I and II) made it possible to prepare maps for the areas at risk (Fig. 3) that were used to redefine areas in Sardinia that were governed by community laws that limited the movement and trade of animals and products to other areas of the island. As seen in Figure 3, most of Sardinia is not considered at risk, while the three indicators used for classification of the risk level indicate that a few areas in the Nuoro region indicate that there has been continued presence of ASF for many years, based on positive serological results from tests conducted on the wild boar population in this area.

Table II
African swine fever risk levels, Sardinia

Risk level	Code	No. of municipalities	Km²	Percentage of territory
0	000	268	15 640	64.96
1	100	29	2 188	9.09
2	001	3	573.1	2.38
3	010	43	2 118	8.80
4	011	6	599.7	2.49
5	110	11	1 406	5.84
6	101	8	527	2.19
7	111	9	1 023	64.96
Total Sardinia		377	24 074.8	100.00

Table I
African swine fever risk areas in Sardinia: classification key

Risk level	Risk code	Outbreaks before 2003	Outbreaks 2004-2005	Seropositive cases in wild boar	No. of municipalities	Municipalities (%)	Cumulative percentage
0	000	No	No	No	268	71.08	71.08
1	100	Yes	No	No	29	7.69	78.77
2	001	No	No	Yes	3	0.79	79.57
3	010	No	Yes	No	43	11.40	90.98
4	011	No	Yes	Yes	6	1.59	92.57
5	110	Yes	Yes	No	11	2.91	95.49
6	101	Yes	No	Yes	8	2.12	97.61
7	111	Yes	Yes	Yes	9	2.38	100.00

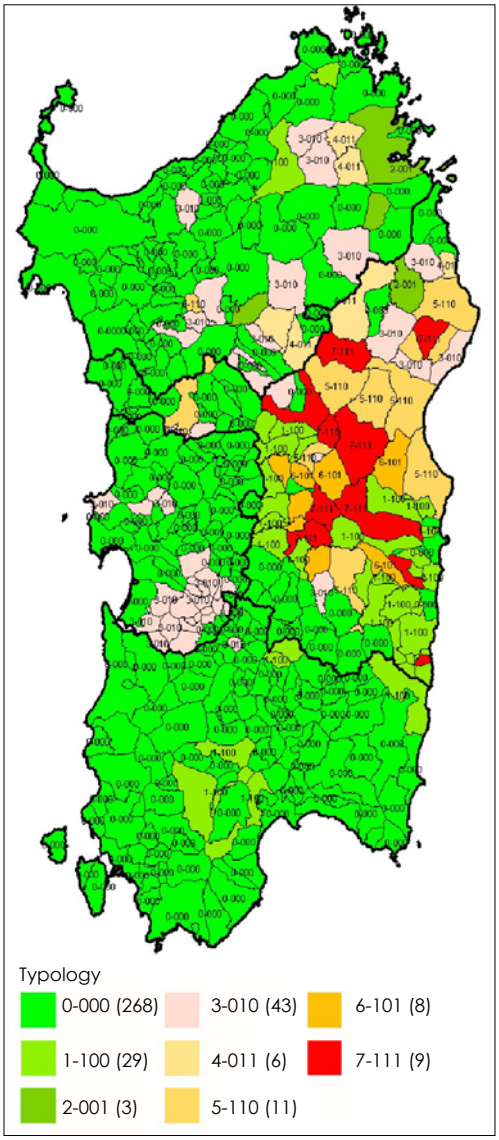

Figure 3
African swine fever risk areas in Sardinia

Discussion

The results of tests and a comparison with the data of the last two ASF epidemics led to a new delimitation of high-risk areas in Sardinia. The wild boar plays a different role in the virus transmission chain which raises questions about the exclusive role of reservoir played up to now. Observation of the serological prevalence rate calculated for the 2005-2006 hunting season showed wild boar positive to ASF in endemic areas (areas 2, 5, 7, 6, 20, 4, 9, 8, 11, 13 and 22 in Fig. 2), or areas where the disease had occurred from 2004 onwards (areas 1, 2 and 17 in Olbia-Golfo Aranci, Padru-Budoni in the Gallura region and Bultei-Pattada in the Goceano region, respectively). No serologically positive wild boar was observed in areas where outbreaks of ASF were observed in 2005 (Ales-Mogoro). This finding supports the hypothesis advanced by the authors in previous years (5), that the presence of wild boar does not represent a significant risk factor, but rather that the animals are infected through direct contact with infected domestic free-range pigs. Seroprevalence rates vary significantly, depending on the area concerned: in the 13 areas where 88 seropositive wild boar were observed, prevalence ranged from 1.20% in area 17 (Bultei-Pattada) to 32.22% in area 9 (Orgosolo-Dorgali).

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