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Evaluation of the first oral rabies vaccination campaign of the red foxes in Greece

Laskarina-Maria Korou[a,*], Konstantia E. Tasioudi[b], Myrsini Tzani[a], Athanasios Konstantinidis[c], Aikaterini Plevraki[d], Peristera Iliadou[b], Petroula Kostoglou[a], Dimitrios Kaimaras[e], Spyridon Doudounakis[a], Olga Mangana-Vougiouka[b]

[a] Animal Health Directorate, Ministry of Rural Development and Food, Athens, Greece
[b] Virology Laboratory, Department of Molecular Diagnostics, FMD, Virological, Rickettsial and Exotic Diseases, Athens Veterinary Center, Ministry of Rural Development and Food, Athens, Greece
[c] Veterinary Department, Regional Unit of Larissa, Greece
[d] Veterinary Department, Regional Unit of Thessaloniki, Greece
[e] Directorate of Technical Studies, Structures and Topography, Ministry of Rural Development and Food, Athens, Greece

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ABSTRACT

Following the late 2012 recurrence of rabies in wild foxes (*Vulpes vulpes*) in central and north-western Greece, the first oral fox vaccination campaign co-financed by the European Union (EU) and the Greek state budget, was implemented. Initially, it involved 24 regional units of the Greek territory during the period October–December 2013. Vaccine-baits were aerially distributed by fixed-wing aircrafts. Vaccines were scattered along parallel flight paths 500 m apart in order to optimize aerial missions and achieve homogeneous distribution. A geographical information system was used to objectively evaluate bait distribution. This system identified areas of inadequate bait density that would require additional flights. A total number of 1,504,821 baits were distributed covering an area of 54,584.29 km^2. To assess the effectiveness of oral vaccination campaign a monitoring program was introduced, which entailed examination of serum samples and canine teeth derived from red foxes collected in the field. The laboratory analysis revealed 60% seropositivity and detection of tetracycline biomarker in 70% of the foxes tested.

1. Introduction

Following 25 years of rabies-free status in Greece a rabid red fox (found in Kozani regional unit) was first detected and laboratory confirmed in October 2012 [1]. The recurrence of rabies in Greece was not an unexpected phenomenon. During the last decades rabies had already been established mainly in wildlife animal population of central and eastern Europe and rabid animals had been detected in the neighboring countries. Red fox currently remains the main virus reservoir in many countries across Europe including Greece [2].

Although rabies transmission within wildlife is considered to be density-dependent, radical reduction of reservoir species population has failed to eliminate the disease or its spread to uninfected areas [3,4]. Additionally, humane and ecological aspects should be taken into consideration before engaging such methods of rabies control in large-scale culling campaigns.

Mass vaccination of the principal wildlife hosts could be a more effective control method than reducing their population [4,5]. Vaccination strategies of wildlife were applied in Europe since the late 1970s in order to control the spread of rabies virus. Switzerland was the first European country to implement oral vaccination in 1978 [6]. The aforementioned programs contributed to achievement of rabies free status after years of oral vaccination in many EU and non EU countries of Europe [7]. Oral rabies vaccination campaigns in Europe are usually conducted twice a year, in spring and autumn with bait distributed mainly by air [4].

To address the epidemic and prevent its spread, a Greek National Rabies control and eradication program was implemented based on passive surveillance of the disease, mandatory vaccination of all

Abbreviations: EURL, European Union Reference Laboratory for rabies; NRL, National Reference Laboratory for Rabies (NRL) in animals, which is the Virology Laboratory of Athens Veterinary Center of the Ministry of Rural Development and Food; DZ, Department of Zoonoses, Animal Health Directorate, Ministry of Rural Development and Food; FAT, direct fluorescent antibody test; FYROM, Former Yugoslav Republic of Macedonia; ORV, oral rabies vaccination; RFFIT, Rapid Fluorescent Focus Inhibition Test; Hellenic CDC, Hellenic Center for Disease Control.

* Corresponding author at: Department of Zoonoses, Animal Health Directorate, Ministry of Rural Development and Food, Veranzerou 46, 10438 Athens, Greece. Tel.: +30 210 212 57 25; fax: +30 210 82 52 614.
E-mail address: koroumarilina@gmail.com (L.-M. Korou).

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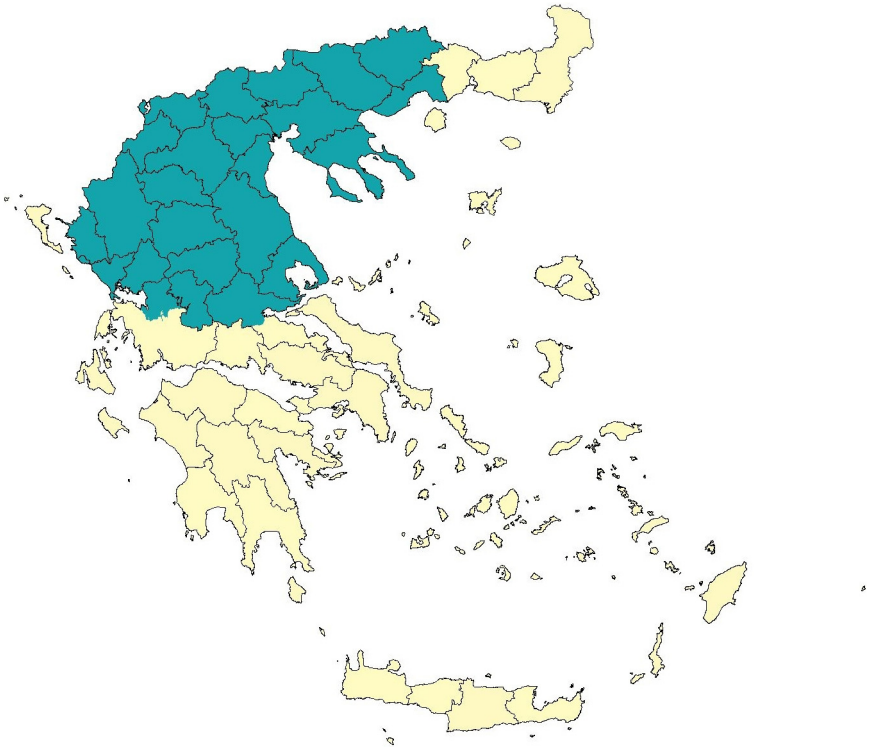

Fig. 1. Vaccination map in Greece. The twenty-four Regional Units of Central and North Greece involved in the first Oral Rabies Vaccination Campaign of red foxes in 2013 are presented in dark color.

dogs and cats, management of all rabies cases – suspected cases and control of animal movements. Furthermore, an Oral Vaccination project for the immunization of red foxes against rabies was launched in Greece and the first vaccination campaign took place in autumn 2013. Vaccine-baits were aerially distributed in 24 regional units of the country.

An assessment of the efficacy of this oral vaccination program was achieved by detection of tetracycline in the canine teeth of the red foxes, which is a biomarker incorporated in the vaccine bait and detection of rabies antibodies in animal's serum collected from areas of vaccination [8].

The aim of this study is the detailed demonstration of the application of oral vaccination in foxes for the first time in Greece and the evaluation of the outcomes of this program.

2. Materials and methods

2.1. Pre-vaccination period

The red fox oral vaccination campaign of autumn 2013 was the first to be carried out in Greece and as a result there was an increased need for preparation, proper design and collaboration of different competent authorities. The Department of Zoonoses (DZ) of the Ministry of Rural Development and Food coordinated the program. Initially, it was decided to implement the vaccine campaign in 24 regional units of the country, which encompassed locations of positive animal rabies cases as well as areas in close proximity to the previous ones. The program was co-financed by the EU and the Greek state budget.

The DZ addressed to different services that could support the program by kindly providing their experience. The Greek Army provided information regarding the design of flights and the permissions required for the implementation of aerial missions. The topography service of the Ministry worked in parallel with the DZ in order to define the total area of the country to be covered by aerial distribution of vaccines. They had to take into account the maximum altitude where red foxes inhabit and the lower temperatures corresponding to each altitude, so as to avoid freezing of the liquid content of the vaccine. It was assumed that the fox density in the landscape over 1000 m above sea level was relatively low and these areas were excluded from the vaccination program. In addition, the altitudes selected were below the freezing level according to previous practices [9].

Urban and suburban areas as well as roadways and water surfaces (sea, rivers and lakes) were excluded from the target area. The cartographical background of national topography service was used in order to estimate the areas that had to be covered. Specifically, polygon-shaded maps were created. Afterwards, the areas of the polygons in the maps, whose the use was not urban, semi-urban or water surfaces, were added. Thus, the total area to be covered was initially calculated to 59,603.51 km^2 (Fig. 1). The density of distributed baits per km^2 was initially estimated to be over 20 (25 baits on average), according to experience gained from other EU and non EU countries [10], since accurate data on fox population in Greece are limited.

The Hellenic National Meteorological Service provided detailed weather forecasts throughout the vaccination program concerning the selected areas. Additionally, they supplied average temperatures derived from different meteorological stations, located in different altitudes, in the areas included in the vaccination schedule.

The vaccine selected for the first oral vaccination campaign in Greece was the SAG2 vaccine (RABIGEN® SAG2), a modified live attenuated rabies virus vaccine, derived from the SAD Bern strain in a two-step process of amino acid mutation using neutralizing monoclonal antibodies. This vaccine has been shown to be non pathogenic after experimental exposure of multiple target and non target species, including non-human primates [11]. However, given