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Review

African swine fever in the North Caucasus region and the Russian Federation in years 2007–2012

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ABSTRACT

Since the introduction of the virus into the Republic of Georgia in 2007 African swine fever (ASF) has become a large-scale epidemic involving the domestic pig population but wild boars are involved as well. From 2008 to 2009 the ASF epidemic affected wild and domestic pigs in all the southern regions of the Russian Federation (RF). The driving force of the epidemic in its initial stages was direct contact between infected wild boars and between wild boars and traditionally free-ranging domestic pigs in backyard farms.

Driving forces of the epidemic at the its first stages was direct contact of infected wild boars between each other and with traditionally free ranged domestic pigs in backyard farms. The next stage developed due to illegal movement of pig products contaminated by African swine fever virus (ASFV) from affected regions and swill feeding, and inefficient implementation of measures to prevent and control ASF. From 2010 through 2012, ASF spread to other, previously unaffected regions of the RF. Most of outbreaks in the southern regions (Krasnodar, Stavropol, Rostov regions) are secondary.

Currently, the disease situation observed in endemic areas of the RF, including the southern Krasnodar and Volgograd regions and the central Tver' region, is very complicated. In 2012, a large number of outbreaks in domestic pigs and in wild boars were reported. The circulating ASFV is highly virulent and has maintained its virulence throughout the epidemic since its introduction in 2007.

Considering the forces currently driving the ASF epidemic – circulation of ASF virus in wild boars, ineffectiveness of prevention and control measures, lack of common interest in eradicating the disease and absence of a nationally funded eradication program – continued outbreaks, including those in previously unaffected regions of the RF, can be expected.

Contents

1. Introduction

African swine fever (ASF) is among the most important swine diseases given its significant sanitary and socioeconomic consequences. The ASF virus (ASFV) causes immune suppression and very high mortality rates in susceptible domestic swine, so that the effect of disease outbreaks is severe.

Pigs become infected mainly through the oro-nasal route after contact with infected pigs or after feeding on virus-containing pork or other contaminated products (swill and garbage waste). Stability of the ASFV virion in a protein environment exacerbates disease spread, and high levels of environmental contamination

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facilitate spread via fomites – contaminated vehicles, equipment, instruments, and clothing – and even possibly insects. European wild boars (*Sus scrofa*) are equally susceptible to ASF, making it very difficult to eliminate once it has become endemic in these wild populations. Notably, ASFV is the only known DNA arbovirus, naturally occurring in eastern and southern sub-Saharan Africa where it is transmitted between ticks of the genus *Ornithodoros* and wild swine species which remain asymptomatic. Thus, establishment of ASFV in soft ticks during outbreak situations can further frustrate control efforts. Lack of effective treatment and vaccine against ASF make control of this disease problematic and based only on sanitary measures such as stamping out and strict quarantine (EFSA Panel, 2010; Penrith and Vosloo, 2009; Terrestrial code OIE, 2012).

ASF is considered a hemorrhagic disease in pigs and wild boars due to the hemorrhagic picture typical of the acute form of the disease. As it is similar clinically to other hemorrhagic diseases such as classical swine fever, salmonellosis or erysipelas, ASF can only be suspected on clinical examination alone and must therefore be confirmed in the laboratory. Pathological findings include extensive hemorrhage in lymph nodes, spleen and kidneys, all of which are additional indicators of ASF.

ASF can present different clinical signs depending on the virulence of the virus, the infectious dose, and the mode of infection, with a range of clinical forms varying from acute to subclinical and chronic. ASFV has been reported to decrease in virulence over time after disease outbreaks in domestic swine, with a certain percentage of infected swine developing a chronic form of disease and establishing a carrier state with subacute clinical signs (EFSA Panel on Animal Health and Welfare, 2010).

The first official report of ASF in the Caucasus region was received from Georgia in the summer of 2007. ASF spread throughout the Caucuses to Armenia, Azerbaijan, Abkhazia and South Ossetia, and in November 2007 the infection was introduced into a population of wild boars in the Chechen Republic of the RF (http://web.oie.int/wahis/). ASF has since become epizootic in the RF, demonstrating disease patterns that include regional foci of infected wild boars in Chechnya and Ingushetia, infected wild and domestic pigs in North Ossetia Kabardino-Balkaria, and large-scale distribution and spread to Northwest Russia. The disease area currently includes almost the entire North Caucasus, the south RF, and some regions of the European RF.

Since its first introduction into the RF, ASF has been characterized by hemorrhagic clinical signs and the acute clinical form of disease. The incubation period is the time that elapses between exposure to a virus and the appearance of clinical signs. In natural occurring cases the incubation period cannot be determined because the time of exposure is not known, but in animals infected by "caucasian" isolates experimentally it was on average about 3–5 days (Belyanin et al., 2011).

No changes in the pathological and epidemiological pattern of the disease have been observed. Although chronic or subacute forms of ASF have not been reported in the RF, there are no data to confirm the absence of recovered or subacutely infected animals, but it is not possible to exclude the existence of asymptomatic carrier animals by clinical inspection. The potential evolution of ASFV should be considered given the emergence of attenuated forms in other outbreaks. To monitor this, systematic serological surveys should be conducted on farms in affected areas. However, the genotype II virus that was first isolated in eastern Africa in 1997 continues to cause outbreaks of acute ASF in Mozambique and Madagascar as it did when introduced into the Caucasus and Mauritius in 2007, suggesting that any change in virulence would require a very long period of time (M.L. Penrith, personal communication, 2012). There is no indication of involvement of *Ornithodoros* or other ticks in the RF epizootic.

Currently, ASF affects more than one third of the RF. Lack of adequate federal and regional legislation, a coordinated national control program, enforcement of ASF control and prevention policies (including bans on trade of pigs and pork products and on traditional swill feeding), pig production infrastructure, and disease traceability are major obstacles in ASF control in Russia. As a result, the disease is spreading among domestic and wild pigs, with especially dramatic events taking place during 2012 in the Krasnodar and Tver' regions. The aim of this review is to summarize the epidemiological data from the ASF epidemic.

2. ASF introduction into the North-Caucasian countries and the Russian Federation

In April 2007, a new outbreak of ASF p72 genotype II, compatible with the virus circulating in Mozambique, Madagascar and Zambia, reached the European continent via Georgia (Rowlands et al., 2008).

ASF in Georgia was not reported to the OIE until 5 June 2007. The first clinical cases were seen before May 2007 in the area surrounding of the port of Poti. Incorrect diagnosis and inadequate disease control measures resulted in its introduction to neighboring countries (Beltran-Alcrudo et al., 2008). The geographic proximity of ASF-affected regions and presence of susceptible wild boars along the rivers flowing from the Small Caucasus toward the Chechen Republic, Ingushetia, North Ossetia-Alania, and Kabardino-Balkaria also contributed to ASF introduction into Russia.

By May 2007 the disease spread across all the eight areas of the Republic of South Ossetia-Alania (RSOA). As many as 1500 animals of the 40,000-head pig population of the Republic died because of the virus. The RSO authorities instituted some preventive measures and organized the destruction of the whole pig population within in a 10-km zone around the ASF foci. Thus, thousands of pigs were destroyed (i.e., incinerated or buried). Nevertheless, the disease manifested itself again in 2010.

The first report about mass mortality of pigs in Abkhazia was received on July 10, 2007 from Lata village (Gulripshsky district) where on July 4 2007 a massive death of pigs (87 of 140 heads) was registered.

Researchers of the Institute for Veterinary Virology and Microbiology were involved in conducting an epidemiological investigation of these outbreaks and concluded that contact between domestic pigs and wild boars may have been a contributing factor in disease spread. Before ASF introduction, free range pig farming was widely practiced in the country, where wild and domestic pigs grazed freely together and numerous cases of mixed offspring were reported (Gerasimov et al., 2008a,b).

During the summer of 2007 ASF affected more than 70% of Abkhazia. Outbreaks were located in districts bordering Georgia along the rivers running from Georgia to the Black Sea coast and along major highways. Stamping out was conducted in eight districts of the republic (see Table 1).

Table 1
ASF eradication in Republic of Abkhazia in numbers.

District	Number of pigs		
	In total	Buried	Processed
Gagry	3999	0	0
Gudautsky	1827	0	0
Sukhumsky	1631	111	1520
Surhumi city	350	145	205
Galripshsky	4100	1231	2869
Ochamchirsky	17,562	6408	11,154
Takuarchalsky	5780	2206	3574
Galsky	9600	5175	4425
Total	39,023	14,101	24,992

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Most of the affected animals suffered an acute form of the disease with characteristic hemorrhagic signs of ASF. Zoning was implemented in an attempt to eradicate the disease. For activities in each district, special functional groups were organized. Free-ranging pigs were banned. Consumption of swine meat was restricted to clinically healthy pigs, if thoroughly cooked and used by producers for their own needs only (no sale of pork).

The spread of infection was stopped by taking urgent and radical measures – strict quarantine measures and stamping out of the whole pig population in affected and threatened areas except the Gudauta and Gagra areas bordering Russia.

On 4 December 2007, the Russian Federation reported to the OIE the first ASF outbreak since the 1970s. Newly initiated surveillance of wild boar populations revealed fifteen dead wild boars found in early November along the Argoun and the Shatoy-Argoun rivers in the Chechnya districts bordering Georgia.

Subsequent regular monitoring surveys of the wild boar populations carried out in 2008–2009 demonstrated spread of ASF across 12 mountain or foothill districts of the republic (in total 25 confirmed ASF cases in dead or shot wild boars, mainly mature animals, in 24 tracts, forests, or nature reserves). All cases were confirmed by laboratory tests by using ELISA and PCR. The location of ASF outbreaks among wild boar in the Chechen Republic is presented in Fig. 1. Despite the wide prevalence of ASF among wild boars in the Chechen Republic within the observation period, no cases in domestic pigs were found (Kurinnov et al., 2008a,b).

The intensive and permanent transmission of the virus among wild boar populations in infected districts of Chechen Republic resulted in a "release" of the infection into wild boar populations of the neighboring regions, namely Ingushetia (June 2008), North Ossetia (June 2008), Kabardino-Balkaria (December, 2008), and Dagestan (September, October 2009, March 2010).

The spread of ASF to the eastern part of the North Caucasus was confirmed by laboratory analyses of samples collected from wild boars hunted during the period from September to October 2009 and in March 2010 in the Tarum, Kizlyar and Babayurt districts of the Republic of Dagestan.

Unexpectedly, four ASF cases in wild boars were established in early and mid-January 2009 in two reservations ("Debri" and "Beshtaugorsky") of the Stavropol region that are located a considerable distance (150 km) from infected areas (Kabardino-Balkarian Republic, North Ossetia or the Chechen Republic). Given the lack of evidence for virus importation by wild boars from Chechnya, we suggest that there are two possible routes of introduction: (1) consumption by wild boars of infected remains of domestic pigs hidden by their owners (later in 2009, similar episodes of discovering remains of ASF-infected domestic pig in a forest were registered in the Rostov region), or inadvertent transfer of ASF-contaminated material by hunters to feeding places located around the reservations; (2) detection of ASFV in mature wild boars shot in the Shatoy district of Chechnya in June 2009 suggests that a permanent "transit" of the virus by migration of infected wild boar from Georgia is quite possible.

Spread of ASF across the mountain districts of the North Caucasus over an extended period of time, and the fact that virus persistence was observed only in wild boar populations, suggest that a "natural" cycle of the virus has been formed. Rapid spread of ASF, regardless of the season and the dynamics of outbreaks, demonstrate that there are natural foci of ASF in at least two geographic regions of the North Caucasus. Involvement of ticks

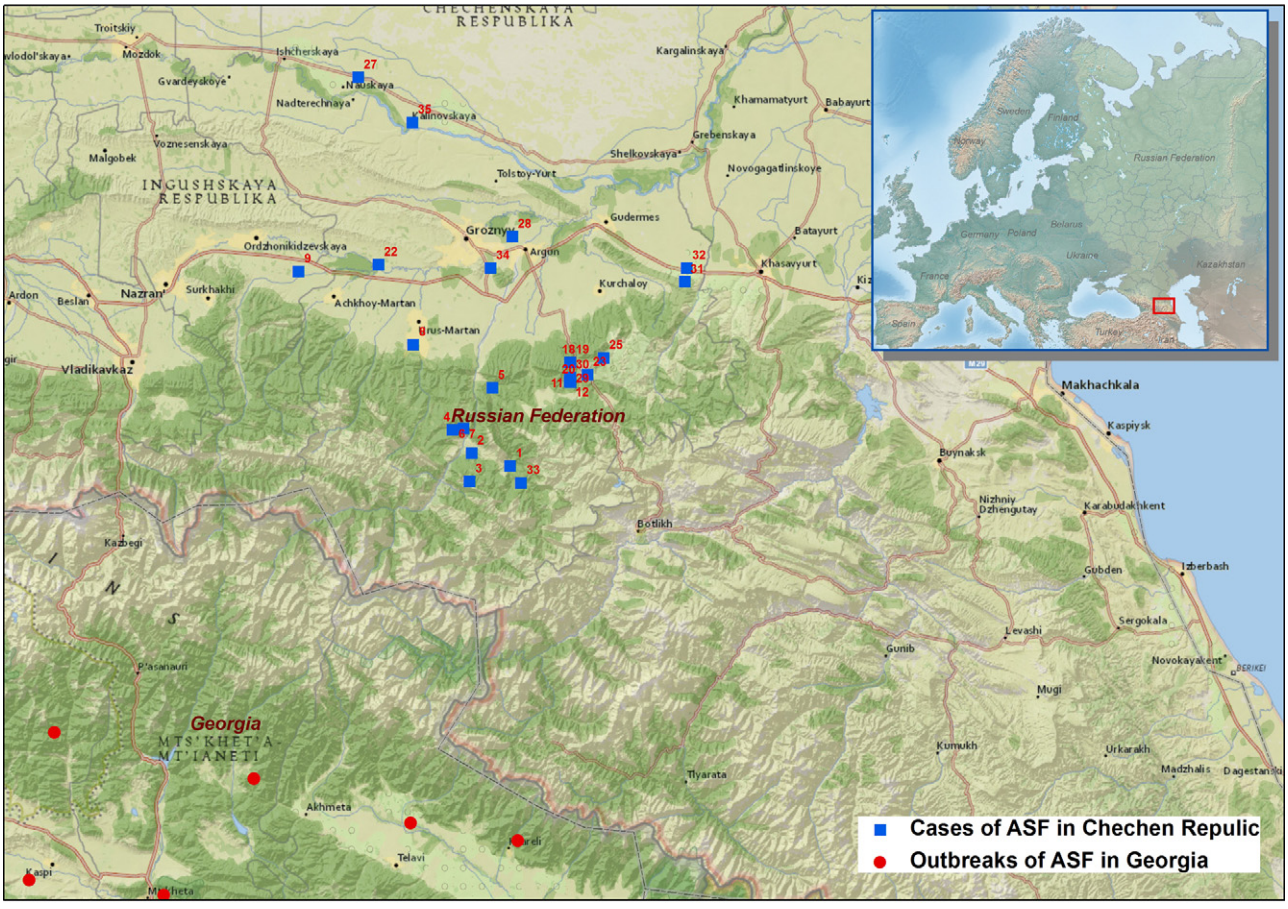

Fig. 1. ASF in Chechen Republic of Russia in 2007–2009.

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Ornithodoros spp. as vector or a reservoir of the ASF virus in the North Caucasus has not been confirmed.

The ASF epidemic that began in Chechnya in 2007 continued to spread in the population of wild boars toward the west. By the middle of 2008, ASF emerged from Chechnya with migrating wild boars, as outbreaks were registered almost concurrently and were accompanied by death of wild boars in several regions of South of Russia, including Ingushetia, North Ossetia and Kabardino-Balkaria. The most likely scenario involved initial introduction of ASFV in early August 2008 as wild boars migrated from South Ossetia. Deaths of wild boars with typical symptoms were registered.

Of great importance in the RF ASF epidemic was the epidemiological chain of events occurring in 2008 in Republic of North Ossetia-Alania and involving direct contact and ASFV transmission from infected wild boars to domestic pigs. This was initiated by the practice of free range pig farming that is traditional in the southern regions of Russia. By February 2009 the disease was registered in domestic pigs in all districts of the republic (46 primary and 6 secondary outbreaks altogether). According to the data provided by the Veterinary Authorities of the Republic of North Ossetia-Alania, by 01.01.2009 as many as 41,885 pigs of various age groups were kept, including 27,271 pigs kept by households and 14,614 animals on commercial farms.

ASFV prevalence throughout the whole territory of the Republic and the 50 ASF outbreaks registered within 5 months in 2008 indicated a rapid transformation of the sporadic pattern into an epidemic form. Analysis of the available epidemiological data and in vivo pathological investigation of the isolates that had caused the outbreaks showed that they were of high virulence.

The long-term intervals observed between the primary and the secondary outbreaks, which lasted from 1 to 17 months, indicated ASFV persistence in the Republic until November 2009 and its transmission with meat and meat products from infected pigs within household domestic swine populations in 32 settlements of the Republic.

According to the Central Administrative Board for Hunting of the Republic of North Ossetia-Alania, the total wild boar population inhabiting the Republic in 2008 was 1394 animals of various ages, 151 of which died in 2008–2009. On the grounds of the Federal State Institution "SOGOOH" of the Prigorodny area as many as 48 wild boars died (the diagnosis of ASF was confirmed in NRIVVaMR). In the Hunting & Fishing Society (HFS) of the Alagir area 17 boars died. In the HFS of the Prigorody area, 8 boars died. In "Fsati-Fund", more than 25 animals died. In a reserve "Turmonsky" of the Digora area, 24 wild boars died. In a FOP "Saur" of the Digora area, where the diagnosis was made following clinical and patho-anatomical manifestations, 29 animals died.

The RF informed OIE that from 15.06.2008 as many as 32 ASF-affected settlements and areas in the Republic had been registered, including 33 outbreaks among domestic pigs and/or wild boars. Nine of them were seen in the Prigorodny area, 2 in the Digora area, 3 in the Iraf area, 4 in the Ardon area, 1 in the Kirovsk area, 1 in the Pravoberezhny area, and 1 in Vladikavkaz. The last ASF outbreak in the RNO-A was in Gizel village of the Prigorogny area (registered on 11.03.2009).

3. The evolution of a large-scale epidemic of ASF in the Russian Federation

ASF in the Stavropol region was an after-effect of an epizootic that had occurred in the RNO-A. As a result, the virus was introduced into both closed and open type smallholdings and pig farms in the Stavropol region. Stavropol also attained an epizootic status with several outbreaks. In October 2008 there were 6 outbreaks in the 4 separate southern areas of Sovetsk, Alexandrovsk, Kirovsk, and Predgorny bordering RNO-A. Six subsequent but sporadic cases occurred in settlements located far away from each other, in the Kursky (January 2009), Apanasenkovskoye (March 2009), Shpakovkoye (May 2009), and Stepnovskoye (November 2009) areas.

Both the route and source of disease spread were the same as in other constituent entities of the North Caucasian Federal District, i.e., unauthorized movement of animals and/or pork sales.

Despite the apparent rapid elimination of foci in settlements and closed type farms, there was no certainty that ASF had been eradicated in the Stavropol and Krasnodar territories. For example, in an epidemiological investigation using PCR, ASFV was found in pork and salted fat stored in refrigerators in Armavir (07.11.2008), and also in those belonging to people living in Stavropol (25.06.2009) and the Bogdanovka village of the Stavropol territory (25.06.2009) in the period between the outbreaks.

The presence of ASF in RNO-A and in the Stavropol area resulted in introduction of the disease into the Republic of Kalmykia (3 outbreaks) and the Rostov region (19 outbreaks) in 2009. These circumstances and the finding of infected meat or pork products clearly indicate that sources of the virus are still present in these administrative areas, and in 2010 four more ASF sporadic outbreaks occurred in the Krasnodar territory (in February and March), and the Rostov region (in February).

The persistent character of the ASF epidemic in domestic pigs suggests that a specific "domestic" type cycle had been established in the North Caucasus of the RF by March 1, 2010. This cycle is maintained by the presence of a viral source, intractable routes of the virus transmission, and inefficient anti-epidemic measures (e.g. elimination of foci), all against a background of pronounced socio-economic problems (i.e., poverty, which leads to the practice of low-cost household pig rearing).

The first case of disease in the Rostov Region was registered at the beginning of April 2009 in the district bordering on the Stavropol and Krasnodar regions. Secondary outbreaks of ASF were only diagnosed in the Rostov region 6 months later (27/09/2009).

Two months after secondary outbreaks, ASF spread rapidly and was found in 29 towns in 8 districts. The lack of cooperation between different authorities and services at the local and federal level contributed to the spread of infection.

In 2011, ASF remained established not only in the endemic area, but was widespread in the central part of Russia. The disease has been registered in more than 190 settlements in 80 districts (North Caucasus, Southern, Volga, Central and North-West) with a total affected area of approximately 600 km^2.

ASF outbreaks associated with cases of "disease jumping" were registered in Arkhangelsk (2 outbreaks), Leningrad (1 outbreak) Murmansk (1 outbreak), Nizhny Novgorod (2 outbreaks), Tver' (9 outbreaks) and Kursk (1 outbreak) regions. Introduction of ASF into these areas was due to illegal movements of infected pork products from affected regions purchased by the food supply and catering service of the security forces and the feeding of food waste to pigs without prior heat treatment.

As part of the disease control efforts in 2011, approximately 140,000 pigs were destroyed in the Russian Federation (http://www.agronews.ru/news/detail/118177/, http://www.fsvps.ru).

In 2012 outbreaks of ASF in domestic pigs have continued in two endemic areas (Krasnodar, Volgograd Region, the Republic of Kalmykia) and in wild boars in four areas (Tver', Volgograd, Novgorod and Krasnodar regions) (Fig. 2). A large number of outbreaks have been registered at large commercial pig farms with "apparent" high levels of biosecurity. For example, in the last several months in the Krasnodar region 26 of the 21 outbreaks registered were in commercial farms. In the Tver' region, 46 outbreaks, 27 of which

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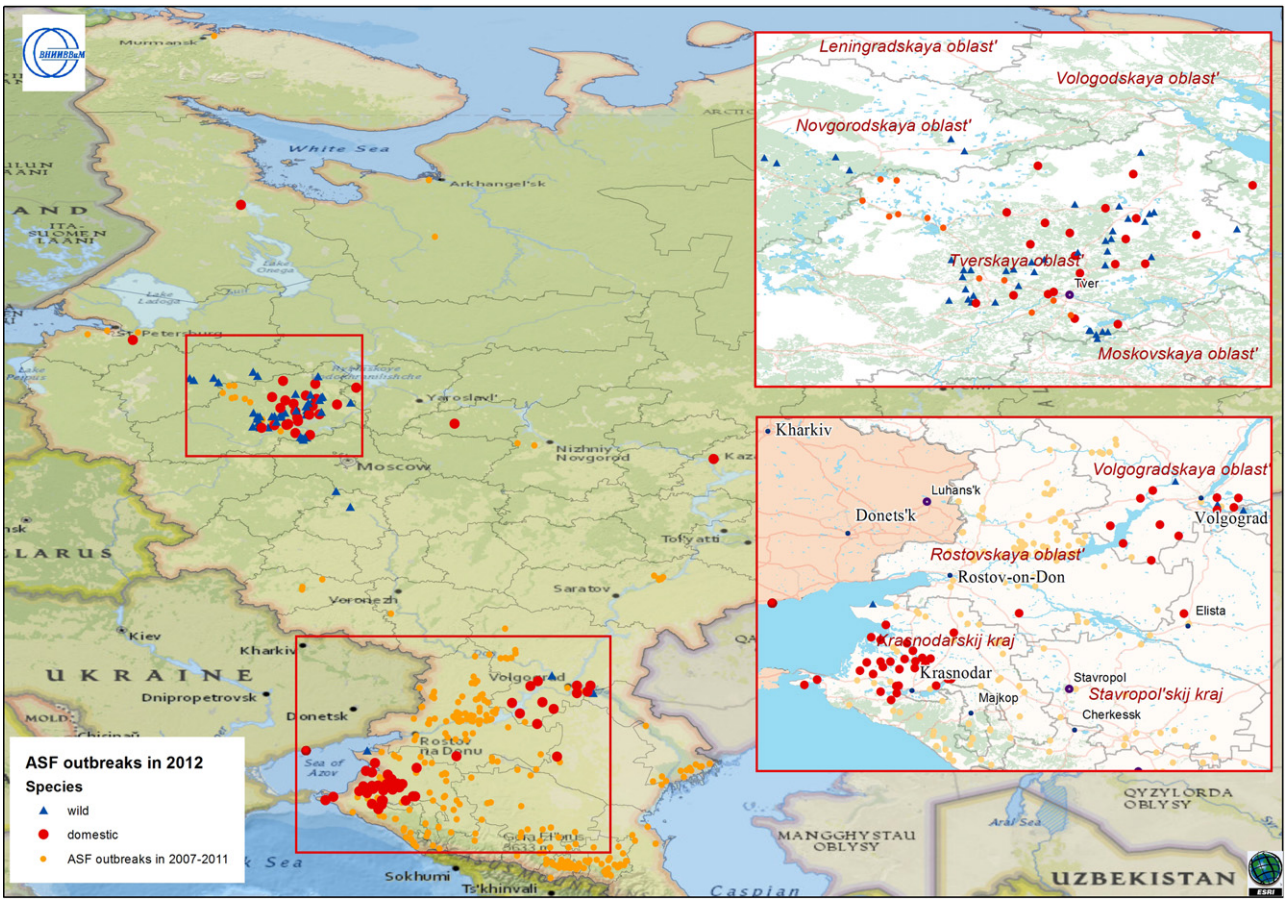

Fig. 2. The spread of ASF in Russian Federation in 2012.

were in wild boars, were registered in 18 of the 36 districts during July and August.

We suggest that the reason for continued ASF outbreaks in these regions is due to the low efficiency of prior disease control methods in these areas, so that contamination of the environment with virus has increased significantly.

It should also be noted that during the ASF epidemic (2007 to the present), the biological properties of the virus have not changed noticeably. Both field observations and laboratory studies indicate that the circulating viruses remain highly virulent. In affected animals the disease occurs mainly in the acute form. The incubation period is 3–5 days. Affected pigs do not usually survive for more than 10 days (Belyanin et al., 2011). In most cases, the clinical symptoms observed are nonspecific (i.e. lack of appetite, depression, shallow rapid breathing, high temperature, in some cases cyanotic discoloration, paresis of the hind limbs, heavy breathing with wheezing, and rhinitis), complicating disease diagnosis.

4. Discussion

The spread of ASF within wild boar populations in the southern regions of the country occurred by direct contact between wild boars because of the high density of animals in these regions. The probability of ASFV transmission in this way is supported by the introduction of ASF into wild boars in Iran in 2008 (Rahimi et al., 2010). Involvement of domestic pigs in the RF epidemic resulted from direct contact between infected wild boars and the free-ranging pigs. Infection of wild boars in the Tver' region, an area far removed from the affected southern regions, likely occurred from infected domestic pigs.

Introduction of the virus into the central European part of Russia occurred by illegal movement of infected meat from affected regions.

The main factors influencing the progressive spread of ASF in the Russian Federation are illegal movement of pork products, untreated swill feeding, free-ranging pig production practices and absence of veterinary oversight for the large number of small backyard farms.

The acute form of the disease occurs in domestic pigs and wild boars with non-specific clinical signs making early diagnosis and intervention problematic. Throughout the epidemic (2007 to the present), the biological properties of the virus have not changed noticeably, with both field observations and laboratory studies indicating that the circulating virus remains highly virulent (Belyanin et al., 2011).

Control of ASF is the responsibility of the various regional authorities. The disease is controlled by stamping out and destruction of all susceptible animals on the affected farm and within a 20 km radius of the epicenter. Quarantine restrictions usually prohibit the movement of all animal products from infected areas but the effectiveness of implementation of these measures is not always adequate. From 2007 to the present, 296,000 pigs have been destroyed as part of the disease control efforts.

Quarantine restrictions usually prohibit the movement of all animal products from infected areas, but these measures are not always effective. Taking into account lack of interest of both government and pig producers to eradicate ASF, the low efficiency of the measures for prevention and eradication, virus circulating in the wild boar population, and finally the absence of a funded national eradication program, we can expect further wide spread

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of the epidemic and most likely involvement of new territories in the process.

Uncontrolled movement of ASFV contaminated pork products purchased by the food supply and catering service of the security forces from affected regions and the widespread practice of swill feeding make for progressive spread of ASF in the Russian Federation, illustrated by the latest outbreak of ASF in the Ivanovo region in the central part of European Russia.

Maintenance of ASFV in wild boar is possible in a region with a high density population, as has occurred in Sardinia (Rolesu et al., 2007). As in Sardinia the wild boar cannot be considered as a primary reservoir of the virus (Rolesu et al., 2007) but plays a role in its maintenance through contact with primary reservoir (dead pigs or free-ranging domestic pigs) and could transmit the disease to neighboring regions or countries.

ASF in Russia has more social character than economic because of the losses to numerous pig farmers, many of whom are poor and depend upon pigs for their livelihood.

Due to lack of interest of the federal government to develop and implement a nationally funded eradication program, all costs associated with ASF outbreaks elimination and prevention are financed by regional budgets and pork producers.

The volume of financial resources and the differences of regional budgets do not allow taking effective and consolidated prevention measures.

Taking into account the progressive spread of ASF in Russia, ineffectiveness of measures that are implemented for prevention and control of ASF, the extensive trade and cultural relations, the significant number of domestic pigs in private farms (compared to the livestock contained in companies with acceptable biosecurity levels), the circulation of ASF virus in wild boars and high density and migration routes of wild boars in the neighboring Russian east European countries, the risk of spreading of ASF virus into these countries remains high. Therefore, ASF has to be considered as a top priority animal health problem and a threat for the whole Europe.

Nevertheless, it is not expected that effective measures against African swine fever in Russia in the near future will be undertaken because of lack of a common interest in disease eradication.

As far as Russia is not an exporter of pigs and pork products, the pork industry is aimed only to the internal market. It should be noted that Russia's entry into the World trade organization (WTO) has led to the fact that even large pig farms, not to mention the smaller producers of the industry, cannot be competitive for products in comparison to foreign suppliers because of high production costs. This has led to uncertainty about prospects for the viability and development of individual industrial pig farms, and industry in general. In these circumstances, additional investment in improving biosecurity pig farms, as well as financing of any other measures aimed to prevention of new outbreaks of ASF, is not viable for pig owners at this point.

Conflict of interest

There are no conflicts of interest.

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