UDC 619:616.98:578.842.1:616-036.22(415)

DOI 10.29326/2304-196X-2018-2-25 -18-25

AFRICAN SWINE FEVER EPIDEMIC IN 2007–2017

PART 1. COMMON ASF TRENDS IN THE RUSSIAN FEDERATION AND IN EURASIA

A. S. Oganesyan[1], M. A. Shibayev[2], H. Ye. Baskakova[3], F. I. Korennoy[4], A. K. Karaulov[5]

[1] Head of Unit, Candidate of Science (Veterinary Medicine), FGBI "ARRIAH", Vladimir, Russia, *e-mail: oganesyan@arriah.ru*

[2] Head of Unit, Candidate of Science (Veterinary Medicine), FGBI "ARRIAH", Vladimir, Russia, *e-mail: shibaev@arriah.ru*

[3] Leading Legal Adviser, FGBI "ARRIAH", Vladimir, Russia, *e-mail: baskakova@arriah.ru*

[4] Researcher, FGBI "ARRIAH", Vladimir, Russia, *e-mail: korennoy@arriah.ru*

[5] Head of the Information Analysis Centre, Candidate of Science (Veterinary Medicine), FGBI "ARRIAH", Vladimir, Russia, *e-mail: karaulov@arriah.ru*

SUMMARY

Results of retrospective analysis of African swine fever epidemic situation in the Russian Federation including analysis of the epidemic chronology indicating significant events of the disease spread across the country's territory are presented. Common ASF epidemic trend and rate in 2007-2017 in Eurasia based on the number of infected countries (1.273 ± 1.272 countries/year) and in the Russian Federation Subjects (4.5 ± 2.3 Subjects/year) are shown. The paper also addresses some peculiarities of the epidemic process depending on the season of a year. Possible social and biological factors contributing to the epidemic spread are examined. Necessity of further search for probable biological vector and examination of social factors that could contribute to the disease maintenance in wild life and in domestic pigs in the Russian Federation and Eastern European countries are discussed.

Key words: African swine fever, domestic pigs, wild boar, epidemic, seasonality of disease.

INTRODUCTION

Colossal efforts taken by the Veterinary Services of countries having suffered from ASF and countries at risk of ASF spread still don't slow down ASF, Genotype II, spread in the continent since it emergence in Georgia in 2007. Development of the strategy aimed at the disease control in the territory of the specific country demands concentration of considerable resources, both material and scientific, considering many factors [8, 12], and consolidation of research and management activities at the international level. Experts have been constantly discussing the ASF situation, i.e. the development of the disease outbreak control and elimination strategies including methods of diagnosis and emergency planning in relevant territories, disinfection, wild bore population control [10]. For instance consideration is given to the peculiarities of pig farming in the region, the structure of the population, technological cycles, pig management culture in holdings of different type, internal and interfarm links in the outbreak area and neighboring territories, zoning, presence of susceptible animal population and possible vector presence as well transport system and ethnic characteristics of the population involved in pig farming, veterinary service activities, etc.

During the ongoing epidemics chronology and character of the ASF spread and common trend of ASF situation development in Eurasia are of special interest.

MATERIALS AND METHODS

Official OIE and FGBI "Veterinary Centre" of the RF MoA data (as of January 29, 2017) on ASF epidemic situation in the RF and countries of the world in 2007–2017 [12, 13], data from open sources on control measures in the EU countries [3, 7, 11, 14] and the RF were used in the research.

Epidemics development analysis in Russia was performed retrospectively. The common ASF development trends in 2007–2017 in the RF and Eurasia are demonstrated both graphically (as polinomial trendlines created on the total sum of the RF infected countries/Subjects) and as calculation of mean values related to newly infected RF countries/Subjects for a year (epidemics development rate).

RESULTS AND DISCUSSION

Analysis of the ASF epidemic development in the RF in 2007–2017. Since 2007 till December 2017 (as of December 2017 (Fig. 1)) 1252 ASF outbreaks were reported in the Russian Federation (765 – domestic population,

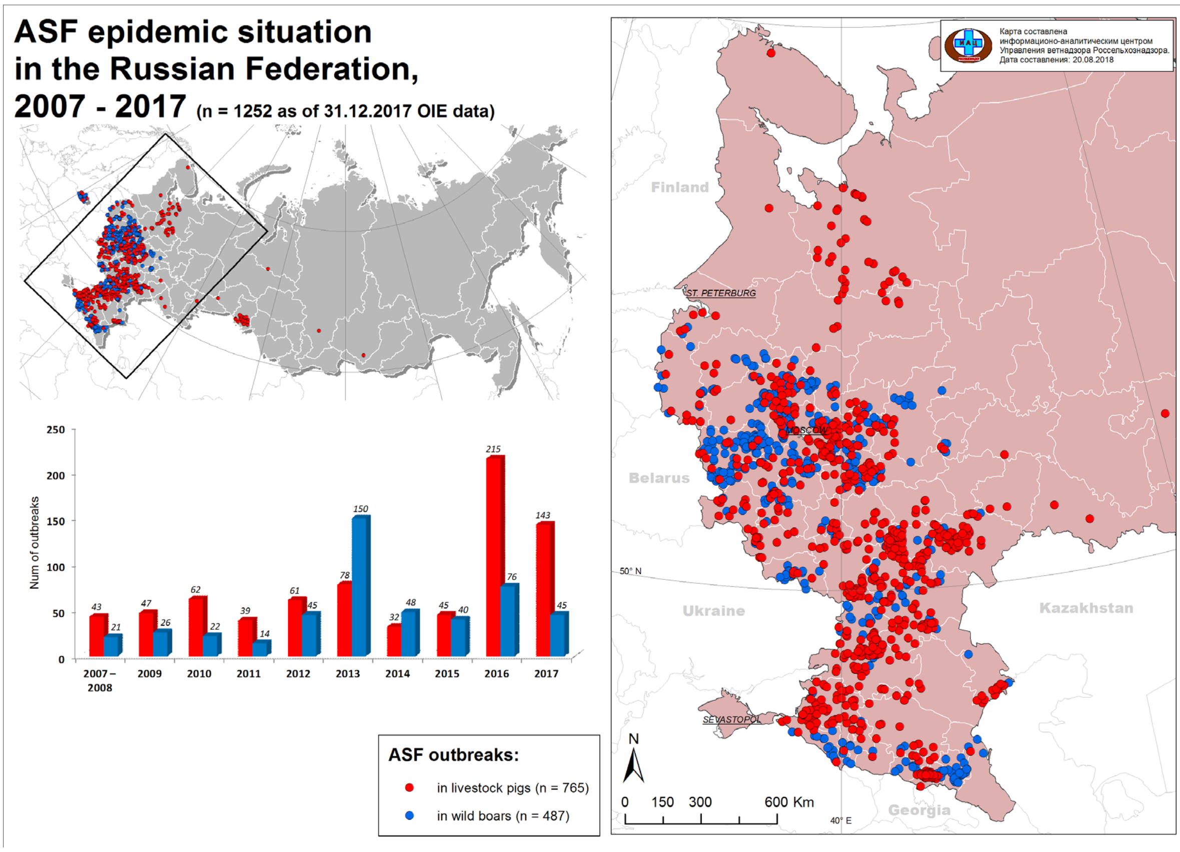


Figure 1. ASF epidemic situation in the RF in 2007–2017 (As of December 29, 2017)

487 – wild population). First ASF outbreak in the RF was detected on November 05, 2007. All in all within this time period the OIE was notified about 1252 ASF outbreaks in 50 Subjects of the country [12].

The analysis of ASF epidemic development in the RF singles out several critical moments:

– **2007** – ASF introduction in the Russian Federation;

– **2008–2010** – establishment of the southern ASF infected zone. First ASF cases introduced from the Orenburg and Leningrad Oblasts (one "long-distance jump" of the disease/a year) demonstrated one more possibility of negative trend of the epidemic development in the country when the disease can spread over considerable distances.

– 2011 – drastic change in the ASF situation. There was reported a surge of ASF "long-distance jumps" (22 cases a year) from the southern infected zone that was established at that time. Within this year ASF spread to Voronezh, Saratov, Archangelsk, Murmansk, Nizhniy Novgorod, Tver and Kursk Oblasts was reported. The secondary northern ASF infected zone was established in the Tver Oblast.

– **2012–2014** – the established infected zones were expanded and formed a single Central-European infected zone. Previously disease-free RF Subjects were involved in the epidemics (Republic of Karelia, Pskov, Novgorod, Yaroslavl, Moscow, Tula, Oryol, Kaluga, Vladimir, Ivanovo, Smolensk, Bryansk, Tambov Oblasts).

As of 2012 – 46 "long-distance jumps" of the diseases were reported.

– **2015** – large-scale ASF spread over Ryazan Oblast was reported alongside with ASF infection of the specified above RF Subject.

– **2016 г.** – The ASF spread scenario with a great number of "long-distance jumps" of the disease was observed again. At this time previously free areas of the Volga Federal District were affected: Penza Oblast, the Chuvash Republic, and the Republic of Tatarstan. Large-scale introduction to Nizhniy Novgorod oblast is observed. The Oblast has had advanced experience of ASF elimination. First cases of the disease were reported in the Lipetsk oblast. And ASF spread to Vologda and Archangelsk Oblasts demonstrated again that it is difficult to control smuggling of goods associated with ASF risks and was indicative of the leading role of the human factor during transboundary ASF spread over considerable distances.

– **Beginning of 2017** was marked with an unusual event – ASF spread from the Central European zone to Irkutsk Oblast.

– **Autumn 2017 г.** ASF was reported in 5 RF Subjects behind the Ural mountains: the Chelyabinsk, Tyumen, Omsk, Krasnoyarsk Krai, and Yamalo-Nenets Autonomous District. ASF spread to the East (Siberia). In the Kaliningrad Oblast the disease was reported in wild boars. ASF outbreak was reported on a large pig farm in Belgorod Oblast. [13].

Preconditions of ASF spread over vast areas were observed as early as in 2016. Thus, during 2016 the disease affected not only the Subjects of the Central Federal District (Voronezh, Tambov, Kursk, Smolensk, Kaluga, Ivanovo, Lipetsk Oblasts) where commercial farming is a quite significant sector, but also new territories of the Volga Federal District (Ulyanovsk, Penza, Saratov, Nizhny Novgorod Oblast, the Chuvash Republic and the Republic of Tatarstan) where the considerable part of domestic pig population is kept by the rural population traditionally engaged in animal rearing.

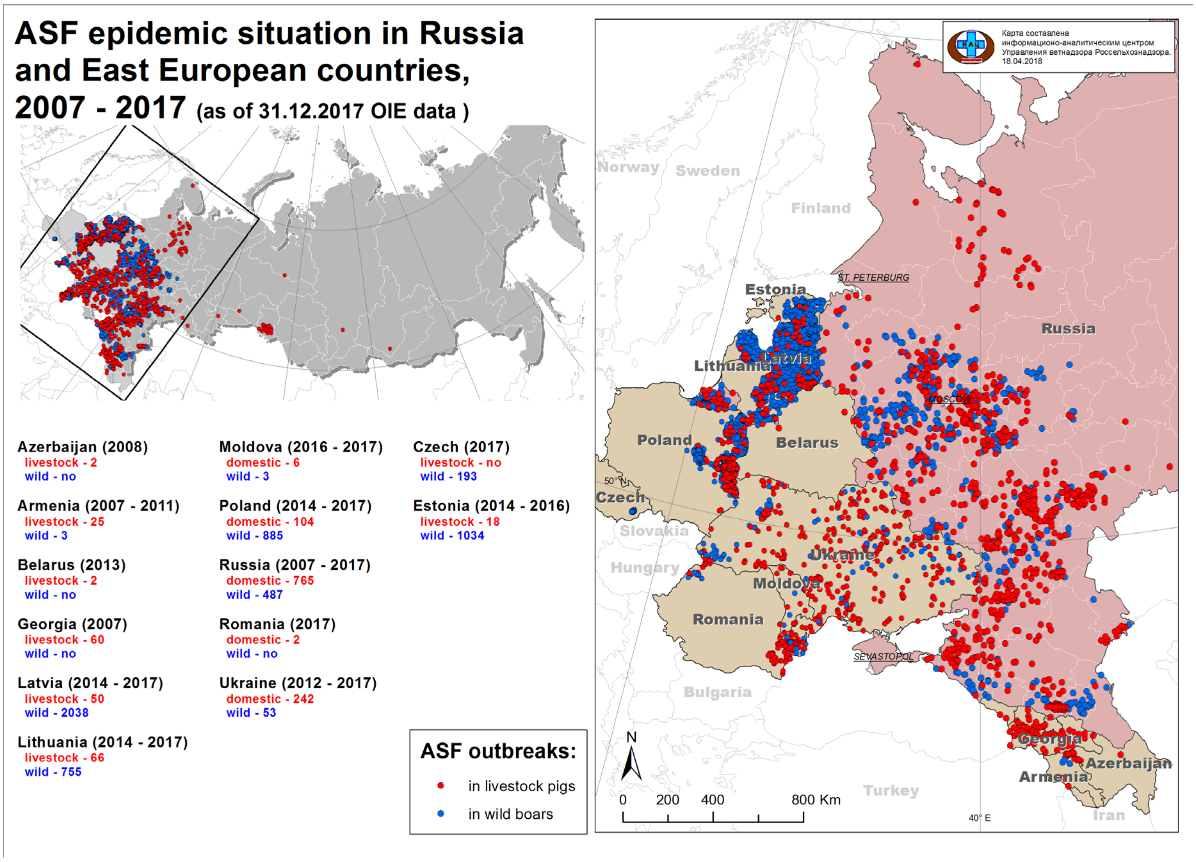


Figure 2. ASF epidemic situation in the RF, Europe and Transcaucasia in 2007–2017 (as of December 29, 2017)

The further negative trend of the epidemics development is of major concern: it is likely that a secondary eastern ASF infected zone can be established in the Subjects of the Volga Federal District and its borders can be expanded to the neighboring Subjects of the Ural Federal District with ASF spread to the Siberian Federal District.

Omitting the issue of ASF spread in the wild boar population, basing on the previous publications it can be noted that the anthropogenic factor in ASF spread in the Russian Federation is prevailing [2, 4]. Target populations in case of ASF spread are backyard farms, herewith the mean disease prevalence in them, at the time when animal health restrictive measures are taken, is 46 ± 43.7% (mean value ± standard deviation), i.e. it can be stated that the disease identification in the disease outbreak is delayed [2].

On the other hand, basing on the results of epidemic investigation of ASF outbreaks on large farms and backyard farms it can be stated that despite of a good level of animal owners' awareness on ASF biological introduction routes and spread there is a factor of taking *risky* pathway *consciously* and *unconsciously* (*note : as for ASF in wild boars in the EU it is specified as "indeliberate" [7]).

Conscious pathway – deliberate actions of animal owners in case he/she realizes the risk (purchase of young animals, feed, meat products from an unknown/illegal source, savings on treatment of feed and food wastes use as feed for pigs). The specified pathway is more common for backyard farms and small farms.

Unconscious pathway – indeliberate actions of animal owners in case they don't realize the risks. It is common both to backyard farms and large farms. For instance, implementation of biosecurity measures on a farm (desinfection barriers, fences, pass control at the entrance) is considered only from the point of view of lifting administrative barrier in order to obtain the status of "protection". On backyard farms implementation of biosecurity rules (change of clothes, control for the tools' use, feeding, watering, pig management, etc) is frequently formal due to the lack of material, technical and logistical resources even if the farmer is sincerely willing to fulfill them.

Table 1
Chronology of ASF Genotype II spread in Eurasia in 2007–2017

Year	Country	Number of countries having reported ASF outbreaks
2007	Georgia, Armenia, RF	3
2008	Azerbaijan	4
2009	–	4
2010	Iran (season 2008–2009 [7])	5
2011	–	5
2012	Ukraine	6
2013	Belarus	7
2014	Lithuania, Poland, Latvia, Estonia	11
2015	–	11
2016	Moldova	12
2017	Romania, Czech Republic	14

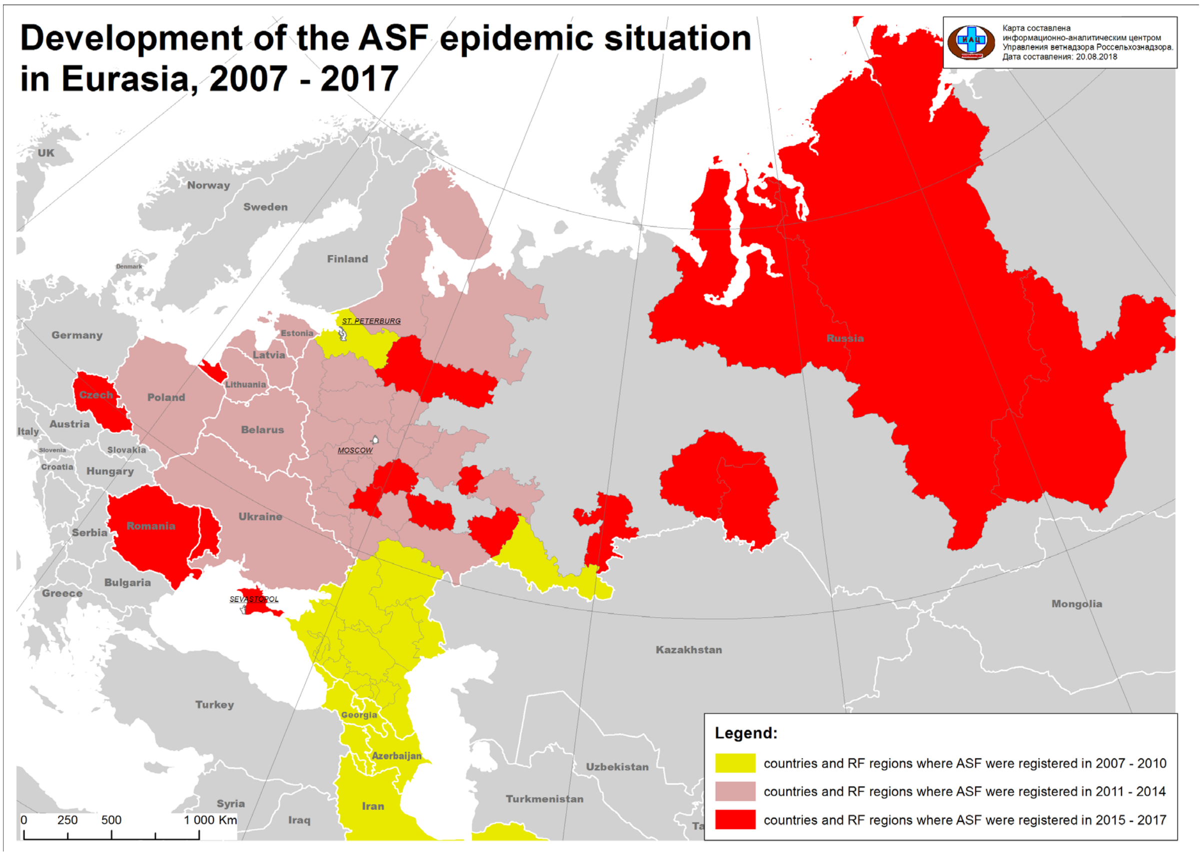


Figure 3. ASF epidemics development in Eurasia in 2007–2017

It is natural that in most cases the specified above pathways are observed either in combination or successively complementing each other. A good example of the combined pathway in backyard farms is the denial of the fact of possible grain contamination with ASFV when unprocessed grain is fed to pigs during grain harvest. Ant here it is important to clarify the probable risk. Actually the grain dispatched from elevators is dried at temperature that decontaminates the virus, which can be present there as a contaminant (as a result of exposure to wild boars). But procurement of the processed grain from the elevator is quite costly for the backyard farm owner. So, sometimes grain that has not undergone proper processing is used as feed. To put it differently poor awareness of animal owners about the infection results from insufficient knowledge communication by the competent services and authorities and inadequate organizational and restrictive measures. Considering this fact the disease spread in the RF will be considerably influenced by backyard farms involved in animal management and the amount of animals in them [4]. Besides, the fact that ASF outbreaks are reported on large pig breeding farms, taking insufficient organizational and restrictive measures, put them on par with biologically insecure holdings (backyard farms). And consequently it allows making a hypothesis about the similarity of causes and routes of the disease introduction to the establishment. Having understood the specified causes of introduction at one level (unprotected populations), with great certainty you can extrapolate them on other levels which will finally have an impact on control and prevention measures.

Common epidemics trends 2007–2017 in Eurasia. When studying ASF genotype II epidemics not only in the RF but on the global scale – in the continent (Eurasia), it should be noted that the trend of ASF epidemics territorial spread in 2007-2017 was quite threatening.

As the table below demonstrates within the *first four years (2007–2010) after ASF genotype II* introduction to our continent five countries were affected (Georgia, Armenia, Azerbaijan, Iran [6] and the RF), i.e. mostly the countries (excluding the RF) where pig production traditionally plays a secondary role or is an "exotic" type of activity.

Within the subsequent four years *(2011–2014)* the epidemics spread over to six more countries (Ukraine, Belarus, Lithuania, Poland, Latvia, Estonia). Herewith, in all the affected countries pork consumption is traditionally high and pig production is industrial. The countries participate in international pig and pig product marketing (Figure 2).

In 2015–2017 the situation in ASF affected countries of the eastern part of Eurasia has aggravated (Figure 3). This is actually overall affection of Estonia, Eastern Latvia and Lithuania, Ukraine, spread in Poland (the borders of the infected Podlaskie Voivodeship that had seemed to be quite stable were broken) and considerable spread to the RF.

Within the last two years Moldova (2016), the Czech Republic, and Romania (2017) officially reported the infection [13].

Summarizing the trends of ASF epidemics spread in 2007-2017 (fig. 4) the general increase in the number of infected regions can be noted.

The total rate of the epidemics development in 2007–2017 is demonstrated in figure 4 as the mean of newly infected countries a year. As for the Russian Federation the epidemics development rate is the average number of new infected RF subjects a year: 1.273 ± 1.272 countries a year and 4.5 ± 2.3 RF Subjects a year.

Basing on the data accumulated during the 10-year experience of ASF epidemics control the disease seasonality can be assessed. ASF spread peak in the Russian Federation and Eurasia in pigs and wild boars reported in July (June-August) [3, 10] can be indicative not of the real seasonality so much of the necessity to study this phenomenon [7]. The fact is that the is no valid biological proof for ASF summer seasonal incidence in wild boars (as there are no reliable data on the presence of sylvatic cycle or cycle "tick-pig" [8] in the RF and Eastern Europe where the virus amplifier similar to *Ornithodoros* ticks and wild wart-hogs is involved [2, 10]), and more likely it is associated with the general ASF peak in summer in domestic pigs. In its turn the summer peak of morbidity in domestic pigs and wild boars is associated with increase in the number of possible indirect contacts between wild boars and domestic pigs due to more intense agricultural (winter crop harvest/field work), tourist (domestic tourism, going to the forest/picking berries, picnics and etc.) and gardening (summer cottage season) activities in the area with a huge amount of backyard farms (rural area) and wild boar habitat [10]. To put it differently the increase in indirect contacts between domestic and wild population is very likely to be observed particularly in summer due to anthropogenic factor [4]. And the existing winter seasonal incidence of ASF outbreaks in wild boars in Eurasia can be explained by the increased wild boar hunting (overdiagnosis) [7]. In any case it will be significant for the disease prevention to find the reasons for ASF seasonal incidence increase.

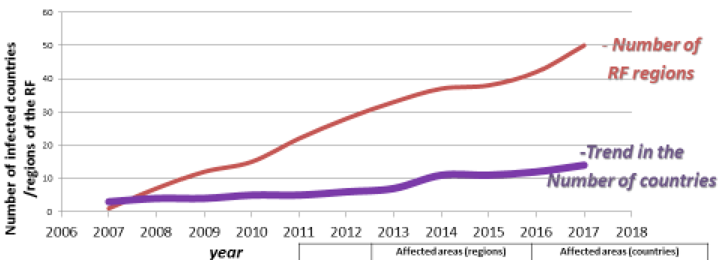
As the ASF epidemic process does not subside in the wildlife of the European part of the continent (as the case may be with highly contagious agents), it is necessary to develop a logic model that would explain the "virus pseudocirculation". One of the explanations of such example could be a hypothesis of the "environmental overloading" according to which wild, underprotected domestic population and ultimately (in case of slightest change in biosecurity) the "protected" population of the pig producing establishment are involved in the epidemic process during ASF outbreak in a certain area through contamination/environmental overloading with the virus and through direct contacts. Herewith, the aspect of wild boar and pig survival after ASF Genotype II infection is quite interesting from the epidemiological point of view. Despite the small amount of surviving/long living experimentally infected pigs and wild boars [5], such cases can indicate that the environment is inhabitant by animals that are likely to contribute to the ASFV "pseudocirculation" both in the wild fauna and on small farms (backyard farms) where the disease recognition at the specified contagiousness index 0.08 is delayed [10]. Which role do "long-living" animals play in the epidemiological process – is a topical question. The probable presence of "long-living" animals and ASFV "pseudocirculation"in the underprotected domestic and wild population can somehow explain low efficacy of ASF zoning measures based on two incubation periods and sluggish epidemics.

Another factor that can cause ASF "pseudocirculation" in the wild fauna is wild boar biology and, in particular, its behavioral particularities: herding lifestyle and restricted contacts between animal herds in case of sedentary lifestyle [7, 10]. It is likely that this is the reason for quite a low rate of interherd ASF spread in the wild boar population. Outbreak seasonality shift to the summer period can be caused not only by indirect contacts between domestic and wild animals, but also by changes in the wild boar lifestyle due to increased human economic activities (movement of herds in directions different from their usual habitat, including moving long distances). The boars are freighted away and the probability of contacts between animals from different herds is higher. On the other hand regular measures aimed at wild boar population reduction also influence the probability of contacts (2014–2017), and as a result the density of the population can be considered to be quite low and controlled taking into account high reproducibility [2, 7, 10].

The veterinary services of the affected countries develop their approach to anti-epidemic measures in wild and domestic populations taking into account the CSF control experience. That's why recording of indirect contacts and environment contamination is of secondary importance. Considerable differences in basic reproduction ratio for ASF and CSF [9] and absence of epidemic waves in case of ASF [10] prove the necessity to further investigate ASF transmission routes in the field and ecological factors such as soil and organisms around the live and dead wild boars (insects and larvae, worms). It is important to clarify the involvement of insects, indirectly contacting with wild boars and domestic pigs through raw feed (for instance, exclusion of the role of insects – crop pests in the wild boar habitat/feeding sites and sites of grain feed preparation for backyard farms).

Analysis of ASF spread in the Russian Federation allows to state that the "long distance jumps" of the disease are very rare – illegal movement of infected meat or pigs from infected regions. These products are transported from backyard farms for far distances quite rarely and at a limited amount. Such legal trade (from backyard farms or unprotected/underprotected farms) between the territories and moreover between the RF Subjects which is characterized by marketing a huge amount of products, is not observed. In most cases the populations of small farms and backyard farms are used for meat production, its marketing on the local market, and for own consumption causing local spread.

Fig. 4. General ASF epidemics trends in 2007–2017



The pace of epizootc for 2007-2016 y.:

The average number of newly affected RF regions per year: ***M±m=4,5±2,3***

The average number of newly affected countries per year: ***M±m=1,273±1,272***

year	Affected areas (regions) in the RF		Affected areas (countries) in the world (Eurasia)	
	New (RF regions)	Total (RF regions)	New (countries)	Total (countries)
2007	1	1	3	3
2008	6	7	1	4
2009	5	12	0	4
2010	3	15	1	5
2011	7	22	0	5
2012	6	28	1	6
2013	5	33	1	7
2014	4	37	4	11
2015	1	38	0	11
2016	4	42	1	12
2017	8	50	2	14

Another (legal) – extremely negative scenario is observed in case of inter-subject pork marketing when due to logistic difficulties and trade routes ASF infected meat, both imported and produced in Russia, and having been illegally marketed, has a potential of distribution for considerable distances (thousands kilometers) within the country through legal trade channels. That's why the control at the border and transport shall be as rigid as possible, and today the increased attention shall be paid to biosecurity on pig producing establishments and meat plants.

So, the diffusive character of ASF epidemics with the cases of the disease spread into the territory of different Eurasian countries does not depend on administrative borders and natural barriers, national territories as demonstrated by the ASF epidemics expansion. For example, Poland having established several zones (2014/709/EC), since February 2014 till August 2017 changed its borders 32 times [14]. Within 10 years (2007–2017) ASF was reported in 50 Subjects (out of 85) [12]. The fact that ASF outbreaks, despite the measures taken by the affected countries, occur at quite a distance from other ASF outbreaks (for example, in the RF – at the distance of ten thousand kilometers, infection in insular territories of Estonia, release to Moldavia) demonstrates that ASF control measures both in the EU and in the RF are not very effective. Despite the measures to be taken are excellently described in laws and national regulations, they, unfortunately, go up in smoke when it comes to the reality (ASF case at biologically secure establishments in the Russian Federation, Lithuania and Estonia).

Human factor is likely to stay the major one in the countries with developed pig production as the investigations performed by the EU surveillance bodies demonstrate and basing on analysis of local cases and "long distance jumps" of the disease in the RF [3, 4, 10, 11]. The probable reasons for ASF occurrence in the new territories and local spread are: illegal movement/trade in pigs and pig products between risk zones; unauthorized (illegal and compromising safety) conscious and unconscious activities on backyard farms and at pig breeding establishments, high probability of surge in the indirect contacts between the domestic and wild population in summer due to anthropogenic factor.

Human behavior as ASF epidemiology factor [4, 7, 10] accentuates the approaches used in disease spread forecasts and taking into account the social factor [1]. Creation of models describing ASF spread with determining the roles of each susceptible and non-susceptible population (domestic pigs, wild boars, rural and urban population involved and not involved in pig production, etc.), directly or indirectly maintaining the process of the disease spread and "pseudocirculation" process, will probably contribute not only to ASF forecasting in the RF and affected countries, but also to the search for social measures, eliminating the mechanisms of risk group formation which will facilitate the elimination of the human factor from the epidemic process.

CONCLUSION

The mean ASF epidemics rate in 2007–2017 in Eurasia was 1.273 ± 1.272 countries a year. In the RF the mean number of Subjects affected a year was 4.5 ± 2.3.

As in previous years, the years of 2016 and 2017 were not an exclusion for expansion of ASF genotype II epidemics borders to the West (Moldavia, Romania, the Check Republic, the Kalinigrad Oblast officially reported the infection. ASF infected zone in Poland has also expanded).

There has been detected the trend of ASF "long distance jumps" the East as well (spread the Volga and Siberian Federal Okrugs of the RF).

ASF "long distance jumps", despite the measures taken by the country, occur at quite a far distance from each other. The human factor is the basic one in countries with the developed pig production both in case of conscious and unconscious activities. ASF summer seasonal incidence can indicate that it is influenced by the surge of agricultural and tourist activity in the wild boar habitat. The research aimed at indirect mechanisms of ASF transmission in the field, ecological factors, (such as soil and organisms around the wild boar and domestic pigs) as well as studies of seasonality and the role of long-living infected animals and mechanisms of risk-group formation associated with the human factor could clarify ASF, Genotype II, circulation under conditions of the European part of the continent and the RF.

REFERENCES

1. Nosova Ye. A. Analysis and mathematic modelling of HIV infection spread: PHD theses … Candidate of Science (Physics and Mathematics). M; 2013. (in Russian)

2. Prediction on African swine fever in the Russian Federation for 2012/S. A. Dudnikov O. N. Petrova, A. S. Oganesyan et al. Vladimir: FGBI "ARRIAH"; 2011. (in Russian)

3. Prediction on African swine fever in the Russian Federation for 2017/ O. N. Petrova, F. I. Korennoy N. S. Bardina et al. Vladimir: FGBI "ARRIAH", 2017. URL: https://www.fsvps.ru/fsvps-docs/ru/iac/asf/publications/asf_prognoz17.pdf. (in Russian)

4. Current habitat structure of African swine fever in the Russian Federation. V. A. Zhuravleva, V. M. Lyska, A. P. Vasylyev et al. *Veterinariya*. 2017; 11: 3–6. (in Russian)

5. Biological characterization of African swine fever virus genotype II strains from North-Eastern Estonia in European wild boar. I. Nurmoja, A. Petrov, C. Breidenstein [et al.]. *Transbound. Emerg. Dis*. 2017; 64(6): 2034–2041. doi: 10.1111/tbed.12614.

6. Emergence of African swine fever virus, Northwestern Iran. P. Rahimi, A. Sohrabi, J. Ashrafihelan [et al.]. *Emerg. Infect. Dis*. 2010; 16(12): 1946–1948. doi: 10.3201/eid1612.100378.

7. Epidemiological analyses of African swine fever in the Baltic States and Poland (Update September 2016 – September 2017) / K. Depner, C. Gortazar, V. Guberti [et al.]; EFSA. *EFSA J*. 2017; 15(11):5068. doi: 10.2903/j.efsa.2017.5068.

8. Epidemiology of African swine fever virus / S. Costard, L. Mur, J. Lubroth [et al.]. *Virus Res*. 2013; 173(1): 191–197.

9. Schulz K., Staubach C., Blome S. African and classical swine fever: similarities, differences and epidemiological consequences. *Vet. Res*. 2017; 48: 84. doi: 10.1186/s13567-017-0490-x.

10. Standing Group of Experts on African swine fever in the Baltic and Eastern Europe region. URL: http://web.oie.int/rr-europe/eng/Regprog/en_GF_TADS%20-%20Standing%20Group%20ASF.htm.

11. http://ec.europa.eu/food/audits-analysis/audit_reports/index.cfm.

12. http://www.fsvps.ru/fsvps/iac.

13. http://www.oie.int/wahis_2/public/wahid.php/Wahidhome/Home.

14. https://ec.europa.eu/food/animals/animal-diseases/control-measures/asf_en.

Submitted on February 09, 2018
Approved for publication on May 22, 2018