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Analysis of Asia-1 foot-and-mouth disease global spread in 1999–2019

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SUMMARY
In spite of current foot-and-mouth disease (FMD) preventive measures, the disease outbreaks are annually reported in different countries of the world. FMD tends to extensive spread and growing into epidemics. While being a transboundary infection according to the OIE/FAO classification, FMD severely affects the economy and international trade. The paper describes the analysis of the data on global spread of type Asia-1 virus-induced FMD in 1999–2019. The virus of this type is most often reported in such Asian countries as Afghanistan, Pakistan, China, Nepal, Iran, Myanmar, from where it can spread to FMD free countries. In China, Asia-1 FMD outbreaks were reported from 2001 to 2009. Previously exotic for our country, the virus of this type was first reported in the Primorsky, Khabarovsk, Zabaikalsky Krais and Amur Oblast in 2005–2006. The results of the phylogenetic analysis of the recovered isolates demonstrated that FMD emergence in the Subjects of the Russian Federation was attributed to the virus introduction from the neighboring territories. Possible virus introduction from China resulted in significant economic expenditures on FMD containment and eradication. In view of the close trade and economic relations between the Russian Federation and such Asia-Pacific countries as China, India, Japan and Republic of Korea, one should place greater focus on the risk of FMDV introduction into the Russian Federation from these countries. Of key importance is intensification of the international cooperation with the Asian countries in the area of joint activities aimed at FMD freedom maintenance.

Key words: foot-and-mouth disease virus (FMDV), type Asia-1, susceptible animals, outbreak, virus introduction, disease spread.

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Анализ распространения вируса ящура типа Азия-1 в мире с 1999 по 2019 год

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РЕЗЮМЕ
Несмотря на принимаемые меры профилактики, направленные на предупреждение возникновения ящура, вспышки заболевания ежегодно регистрируют в различных странах мира. Ящур имеет тенденцию к широкому распространению и приобретению размаха эпизоотий. Являясь по современной классификации МЭБ/ФАО трансграничной инфекцией, ящур оказывает крайне негативное влияние на экономику и международную торговлю. В статье представлен анализ данных по распространению в мире в 1999–2019 гг. ящура, вызванного вирусом типа Азия-1. Наиболее часто вирус данного типа регистрируется на территории таких азиатских стран, как Афганистан, Пакистан, Китай, Непал, Иран, Мьянма, откуда он может распространяться в свободные от ящура страны. В Китае вспышки заболевания ящуром типа Азия-1 регистрировались с 2001 по 2009 г. Ранее считавшийся экзотическим для нашей страны, вирус этого типа был впервые зарегистрирован в 2005–2006 гг. на территории Приморского, Хабаровского, Забайкальского краев и Амурской области. Как показали результаты филогенетического анализа полученных изолятов, возникновение ящура в субъектах Российской Федерации было обусловлено заносом вируса из сопредельных территорий. Вероятный занос вируса из Китая привел к значительным экономическим затратам на ликвидацию ящура и недопущение дальнейшего распространения заболевания. Учитывая тесные торгово-экономические связи Российской Федерации с государствами Азиатско-Тихоокеанского региона, где основными партнерами являются Китай, Индия, Япония и Республика Корея, следует уделять повышенное внимание риску заноса вируса ящура из этих стран на территорию нашей страны. Важную роль играет укрепление международного сотрудничества со странами Азии с целью принятия совместных мер по обеспечению благополучия по ящуру.

Ключевые слова: вирус ящура, тип Азия-1, восприимчивые животные, вспышка инфекции, занос вируса, распространение болезни.

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INTRODUCTION

Foot-and-mouth disease (FMD) is a highly contagious disease of cloven-hoofed animals, which severely affects the economies of the countries worldwide. The key method for the disease prevention involves immunization of the susceptible animals in the areas of high risk of FMD introduction and spread [1, 2]. The disease control is complicated by the diversity of the virus serotypes (types A, O, C, Asia-1, SAT-1, SAT-2, SAT-3), its genetic variability and restricted specificity of the animal immunity within one serotype. There are currently a number of FMD endemic countries. Global FMD situation is extremely sensitive and in spite of all preventive measures taken, the disease outbreaks are annually reported in different countries [3].

Due to the threat of Asia-1 FMD occurrence in Russia, especially along the borders with China, Mongolia and Middle Asian and Transcaucasian countries, the work was aimed at the analysis of the domestic and foreign published reports on global spread of this virus type in 1999–2019.

MATERIALS AND METHODS

Globally reported FMD outbreaks were analyzed with reference to the open access publications in the databases of the World Reference Laboratory for Foot-and-Mouth Disease (WRLFMD, Pirbright, Great Britain) and World Animal Health Organization (OIE) [4–6].

Comparative historical and comparative geographical tools were used for the analysis of Asia-1 FMD epidemic situation.

RESULTS AND DISCUSSION

Serotype Asia-1 foot-and-mouth disease virus (FMDV) is endemic in the Asian region and it was first isolated from the pathological material submitted to the World Reference Laboratory for Foot-and-Mouth Disease in Pirbright from Pakistan in 1954. Retrospective studies of some atypical isolates delivered from Indian town Izzatnagar in 1951–1952 demonstrated that they belonged to serotype Asia-1 and were the earliest documented FMDV isolates of this type. In 1957, Asia-1 FMD was introduced into the Near East, where the first outbreaks were reported in Israel. Later, the serotype became globally widespread [7–9].

In September 1999, Asia-1 FMD became widely spread in Iran, and in October that year, it was reported in Turkey. Then in 2000–2001, it was introduced into Armenia, Georgia, Greece and Azerbaijan, and in 2003 – in Tajikistan. In 2001–2005, the outbreaks of this FMDV type were also reported in Afghanistan, Bhutan, India, China, Laos, Mongolia, Myanmar, Nepal, Pakistan and Thailand. In Vietnam, the FMD outbreak occurred in Ha Giang Province in 2006. In January 2007, FMD clinical signs were reported in calves imported from Liaoning province (China) to the North Korean P'yŏngyang-si Provinces (Ryongkok-Ri, Sangwŏn-gun). In China, the first notifications of Asia-1 FMD were made on March 9, 2005 by Hong Kong, where the disease clinical signs were reported in cattle. Hereafter, the disease was reported in seven more provinces. In 2006, sixteen FMD outbreaks of this type were reported in the country; in 2008 – eight outbreaks and in 2008 – three outbreaks. Of particular note is the fact that in 2007 Asia-1 FMDV carriers were found among cattle in the Xinjiang Uyghur Autonomous Region located in the northwestern part of China along the border with Kazakhstan, Tajikistan, Mongolia and Russian Federation. The disease outbreaks were also reported in this autonomous region in February 2008 and January 2009. FMDV of the same type was detected in other Chinese provinces: Sichuan, Hunan, Guizhou and Shaanxi [10, 11]. In 2009–2011, Asia-1 FMDV of novel genetic lineage Sindh-08 became widespread in Pakistan, Bahrain, Iran, Afghanistan and it was also detected in Eastern Antalya, Turkey in 2011 [8]. In May 2011, the virus of this genetic lineage was officially confirmed in Tajikistan [12]. In 2013, Asia-1 FMDV of the novel genetic lineage BD-18 (G-IX) was reported in Bangladesh [8].

According to the OIE data for 2017, outbreaks of Asia-1 G-VIII FMDV originally detected in Kingdom Bahrain in 2009 were reported in Nepal, Afghanistan and Myanmar.

In 2018, Asia-1 FMD was detected in the following countries: Nepal, Afghanistan, Iran and Bangladesh. Iran and Afghanistan were determined to belong to the genetic lineage Sindh-08.

In 2019, Afghanistan, Bangladesh and Pakistan notified FMDV outbreaks (Fig. 1).

According to the diagram below (Fig. 2), Asia-1 FMD outbreaks were most often notified by Afghanistan (2001–2005, 2009–2011, 2017–2019) and Pakistan (2001–2005, 2009–2011, 2019). In China, FMD of this type was reported in 2001–2009. Asia-1 FMDV circulation is most likely to occur due to uncontrolled migration of cloven-hoofed animals and illegal importation and exportation of animal and plant products [13].

The Russian Federation had been free from Asia-1 FMD until 2005, when fifteen FMD outbreaks were detected in the Amur Oblast, Khabarovsk and Primorsky Krais (Fig. 3). Even though these regions were within the zone where susceptible animals were subjected to preventive immunization against FMD, vaccination against Asia-1 FMD was not carried out. On 9 June 2005, the first outbreak was

confirmed in Busse village (Svobodnensky Raion, Amur Oblast) located on the left bank of the Amur River that separates the settlement from China. In the second half of August 2005, new Asia-1 FMD outbreaks were reported in the Khabarovsk and Primorsky Krais. Around the same time, FMD occurrence was notified in China-bordering Dornod aimag, Mongolia.

In the Khabarovsk Krai FMD was detected in cattle in four settlements in the Bikinsky and Vyazemsky Raions located near the border with China. On 21 August 2005, FMD was confirmed in cattle owned by KGUSP "Lermontovskoye", Bikinsky Raion. The cattle pasturelands were located near Dobrolyubovo settlement on the Ussury River floodplain that borders China. On 23 August 2005, FMD was reported in cattle on the grassland belonging to KGUSP "Lonchakovskoye", Bikinsky Raion. In Vyazemsky Raion FMD was diagnosed in cattle in Vidnoe settlement. On 24 August, in the same raion one more FMD outbreak was reported in Sheremetyevo unit of KGUSO "Kotikovo", where 56 cattle were kept.

Asia-1 FMD became widespread in the Primorsky Krai. The first FMD suspicion was identified in cattle on 26 August 2005, in the backyard in Krasny Kut settlement (Spassky Raion) located near the border with China. From 27 August to 2 September, FMD was detected in seven more settlements in six raions of the Primorsky Krai, four of which bordered China. Thus, in Pavlo-Fedorovka settlement, Kirovsky Raion, and in Abramovka settlement, Mikhailovsky Raion, FMD was diagnosed in cattle on 27 August; and on 28 August FMD was reported in Ignatevka settlement, Pozharsky Raion; on 31 August – on "Primorsky Ris" farm in Sivakovka settlement, Khorolsky Raion; on 2 September FMD clinical signs were reported in cows and in a pig in the backyards in Luchki settlement of the same raion. The disease was confirmed in cows in the backyards in Pervomaiskoe settlement, Khankaisky Raion, on August 30, and in Slavyanka settlement, Khasansky Raion, on September 2. In the Primorsky Krai the last outbreaks were reported in the Lesozavodsky Raion, namely in Nevskoe settlement bordering China [14].

Asia-1 FMD outbreaks continued in 2006. FMD was reported in cattle in the settlements located near the Russian-Chinese border: in Srednyaya Borzya (Kalgansky Raion, Chita Oblast) – on 23 January, and in Kuropatino settlement (Tambovsky Raion, Amur Oblast) – on 22 February [15].

Phylogenetic analysis demonstrated that the Russian isolates were genetically closely related to the virus that had caused large-scale Asia-1 FMD epidemics in China in 2005–2006 [16].

FMD buffer zone was established in Russia and it comprised all the southern border of the country [1, 17]. After the FMD outbreaks caused by Asia-1 virus, trivalent vaccine against type A, O and Asia-1 FMD is used for preventive immunization in the buffer zone. Until 2015, routine preventive vaccination of FMD susceptible animals was also carried out in the Moscow and Vladimir Oblasts, as FMD vaccine manufacturing facilities are located here. Nowadays, these facilities are not part

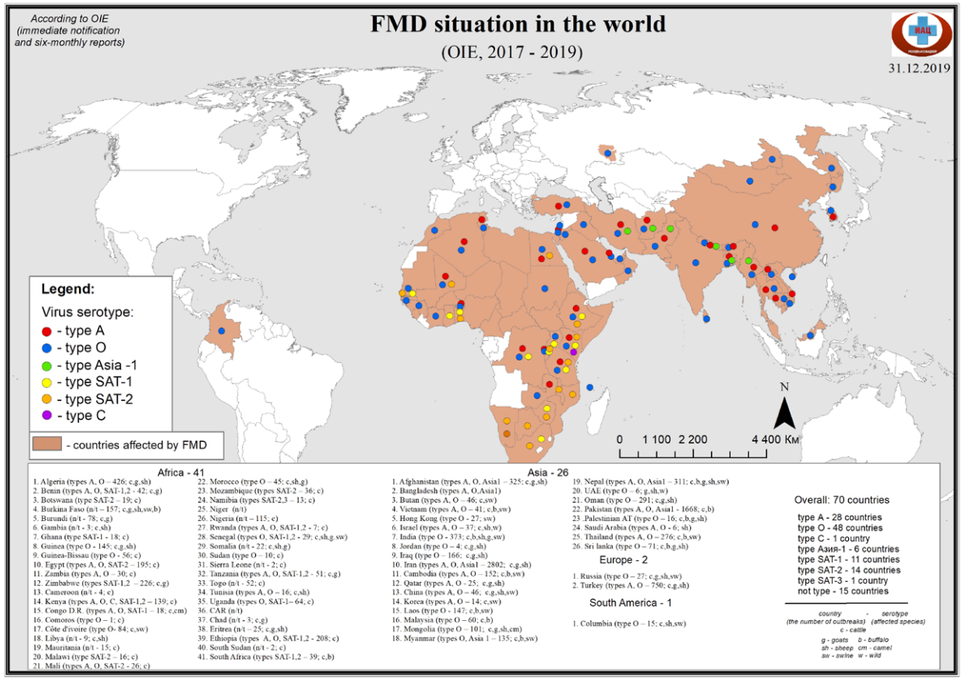

Fig. 1. Global FMD epidemic situation in 2017–2019 (the map has been prepared by the officials of the Information Analysis Centre, FGBI "ARRIAH")

Рис. 1. Эпизоотическая ситуация в мире по ящуру в 2017–2019 гг. (данная карта подготовлена сотрудниками Информационно-аналитического центра ФГБУ «ВНИИЗЖ»)

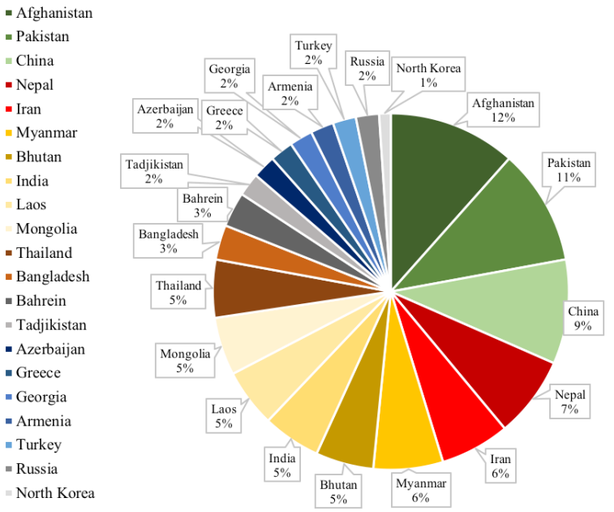

Fig. 2. Frequency of Asia-1 FMD reports in different countries

Рис. 2. Частота регистрации ящура типа Азия-1 в различных странах

of the buffer zone, since they are strictly compliant with the relevant safety requirements aimed at the agent escape prevention (Fig. 4).

On 18 October 2016, Asia-1 FMD outbreak was reported in cattle on one of the farms in Vyshmanovo settlement (Sobinsky Raion, Vladimir Oblast). The disease was eradicated in the primary outbreak area by seizure and destruction of all susceptible animals located in the infected settlement. Epidemic investigation failed to conclusively identify the source of the agent [18].

Of topical significance today is maintenance of FMD freedom in the Russian Federation through the implementation of such measures as monitoring of the global disease situation, preventive vaccination of susceptible animals in the buffer zone using relevant production virus strains and diagnostic tests aimed at the FMDV detection [17, 19, 20].

CONCLUSION

Summary of the data obtained during the analysis suggest that actual situation on global Asia-1 FMDV spread is different from the officially reported one. This is particularly true for Asian and Near Eastern countries, where strict reporting is not carried out due to a number of reasons and in spite of the continuous virus circulation in the regions. Uncontrolled migrations of the wild cloven-hoofed animals (saigas, dzerens, buffaloes) and insufficient financing of the veterinary services in these countries mean that in many outbreaks the viruses remain untyped thus extremely distorting the actual situation with global FMD spread.

Asia-1 FMD inflicted significant damage to Russian livestock production and economy in 2005–2006, when possible virus introduction from China resulted in multiple infection outbreaks in the country as well as in heavy expenditures on their eradication.

In order to minimize the risk of FMDV introduction into our country, special consideration should be given to monitoring of the epidemic situation in Asian countries and to the strengthening of the safety control of the products imported to the Russian Federation. Intensification of the international cooperation with APAC countries in implementation of joint measures for FMD prevention is of major importance.

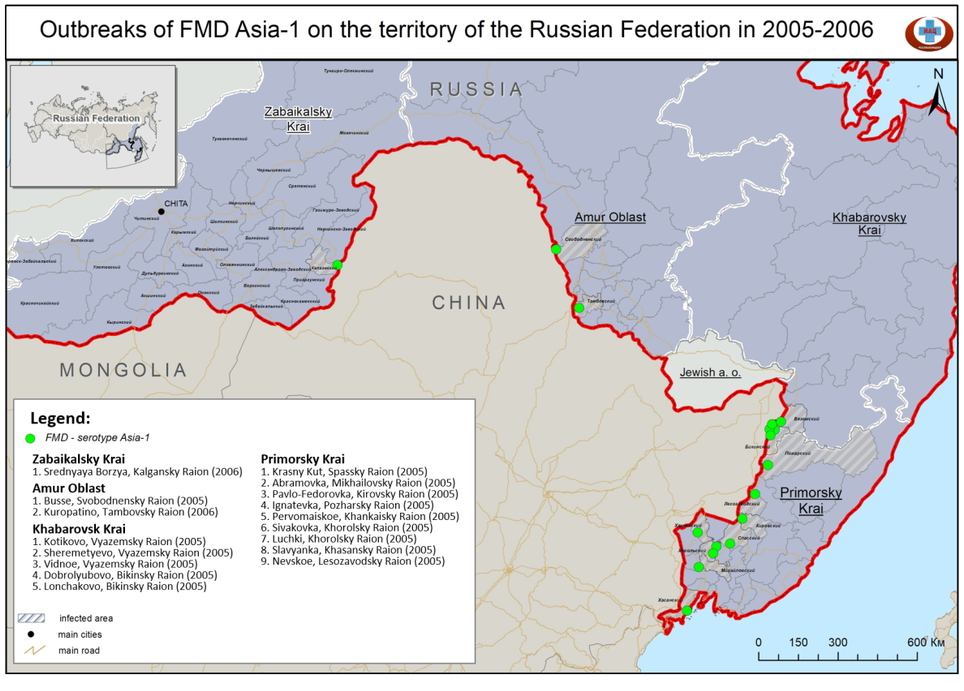

Fig. 3. Asia-1 FMD spread in the Russian Federation in 2005–2006 (the map has been prepared by the officials of the Information Analysis Centre, FGBI "ARRIAH")

Рис. 3. Распространение ящура типа Азия-1 на территории Российской Федерации в 2005–2006 гг. (данная карта подготовлена сотрудниками Информационно-аналитического центра ФГБУ «ВНИИЗЖ»)

Fig. 4. Zone of preventive vaccination against FMD (A, O, Asia-1) in the Russian Federation (the map has been prepared by the officials of the Information Analysis Centre, FGBI "ARRIAH")

Рис. 4. Зона профилактической иммунизации против ящура (A, O, Азия-1) на территории Российской Федерации (данная карта подготовлена сотрудниками Информационно-аналитического центра ФГБУ «ВНИИЗЖ»)

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Quality profile of milk from high producing dairy cows vaccinated against mastitis

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SUMMARY

One of the raw milk quality criteria is the count of somatic cells, produced by the cow's immune system to fight infectious diseases of the mammary gland. The paper presents the analysis of somatic cell count and total bacteria count of milk from cows, vaccinated against mastitis using Startvac vaccine. Tests were performed as a comparison between a dairy unit and a farm under different management conditions and using different milking techniques. Six months after the start of the vaccine application the somatic cell count at the dairy unit decreased by 60 thousand/ml, at the farm by 182 thousand/ml. The agent profile was represented by the following bacteria: *Enterococcus faecium*, *Staphylococcus aureus*, *Streptococcus* spp., *Pseudomonas aeruginosa*. *Staphylococcus saprophyticus*, *Staphylococcus epidermidis*, *Enterococcus faecalis*, *Escherichia coli*, *Bacillus*, *Lactobacillus* were also isolated from udder secretion. After a year of immunization somatic cell count both at the unit and on the farm decreased by 245 and 216 thousand/ml respectively; it is noteworthy that 43.75% of microflora isolated from mammary gland secretion was represented by *Streptococcus* spp. After two years of the vaccine use the somatic cell count was equal to 371 and 725 thousand/ml at the unit and on the farm respectively. Tests of mammary gland secretions revealed *Streptococcus* spp. in 27.27% of cases, *Staphylococcus aureus* and *Enterococcus faecium* were isolated in 18.18% of tested samples. It was established that after three years of the vaccine use the major cause of mastitis in cows was *Streptococcus* spp. (55.00%). During four years of tests, a downward trend in somatic cell count of bulk milk from high producing dairy cows as well as in the number of agents responsible for inflammation in a mammary gland was detected. Somatic cell count of milk from vaccinated animals decreased by 286 and 432 thousand/ml at the unit and on the farm respectively. During the test period *Staphylococcus aureus* isolation rate declined by 19.41%.

Key words: mastitis, Startvac mastitis vaccine, somatic cells, mastitis agents, milk quality.

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Показатели качества молока высокопродуктивных коров на фоне применения противомаститной вакцины

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