UDC 619:616.98:579.852.11

DOI 10.29326/2304-196X-2019-2-29-46-49

GLOBAL ANTHRAX EPIZOOTOLOGY.
3. THE INDEX OF NIDALITY

V. V. Makarov[1], N. Ya. Makhamat[2]

[1] Doctor of Sciences (Biology), Professor, Peoples' Friendship University of Russia (RUDN), Moscow, Russia, *e-mail: vvm-39@mail.ru; ORCID ID 0000-0002-8464-6380*

[2] Post-Graduate Student, Peoples' Friendship University of Russia. (RUDN), Moscow, Russia, *e-mail: mhtnguerabe@mail.ru*

SUMMARY

The index of nidality is the value quantitatively characterizing the activity of the animal infection nidus and grounded on the contagiousness, which is an immanent property of a contagious disease. A detailed statistical analysis of the number of animals being exposed in anthrax nidi globally, based on ProMED and WAHIS summarized data for 2007–2017, is given in the paper. 195 anthrax nidi/outbreaks with n = 12,423 animals (64 animals per outbreak in average) and the largest range of limits from min 1 to max 2600 were taken into consideration. The highest incidence (p) of anthrax (from 27 to 7) accounts for outbreaks, where minimum animals (from 1 to 7) were exposed. The indices of anthrax nidality, which are closest to reality and calculated using statistically reliable sample of average variants (number of outbreaks, exposed animals, mortality) for basic animal species, taken as a percentage of infected animals per one outbreak in average are 11% (from 0.6 to 19) for cattle; 4% (from 1 to 20) for small ruminants; 7% (from 6 to 33) for horses.

Key words: anthrax, epizootology, index of nidality.

In the previous publication [1] the biggest anthrax incidents under different climate and geographic conditions of three continents, defined as hypersporadic, were considered. Their detailed interpretation, clarifying the grounds for hypersporadity able to serve as stereotypes, were given. This work describes nidality as one of the most important epizootological criteria of this disease.

The index of nidality is the value quantitatively characterizing the activity of the animal infection nidus and morbidity in it, grounded on the contagiousness, which is an immanent property of a contagious disease. It is expressed as a percentage of diseased animals among all exposed animals, i.e. present in the outbreak area:

$$X = \frac{\text{(number of diseased animals)}}{\text{(number of exposed animals)}}.$$

This is a static feature, stereotypic for rational infection categories – contagious (highly and low contagious), non-contagious (transmissive), dead-end infections, is relatively specific for some nosological forms and directly correlated with the index of contagiousness (or contact number), that means with the infectivity of the disease, based on the diffusion speed within the susceptible population. In particular a very high index of nidality reaches 1 (i.e. 100% infected among exposed animals) in case of acute epidemic infections, especially highly contagious types of FMD, classical swine fever and Newcastle disease. For low contagious African swine fever, chronic tuberculosis, brucellosis, leucosis the index is much lower. When it comes to sporadic dead-end infections, like rabies of non-host animals, anthrax and other sapronoses, the index of nidality can be extremely low.

The animal infection nidus is the location of the infectious disease source, from which the transmission and further spread among susceptible animals is possible. The nidus can be any population of animals, located in the close vicinity (direct or indirect contact) with diseased or dead animals or contaminated articles, i.e. exposed to a disease outbreak. Typological and topological scope of the nidus, or number and structure of susceptible animals and territorial range can *a priori* vary extremely.

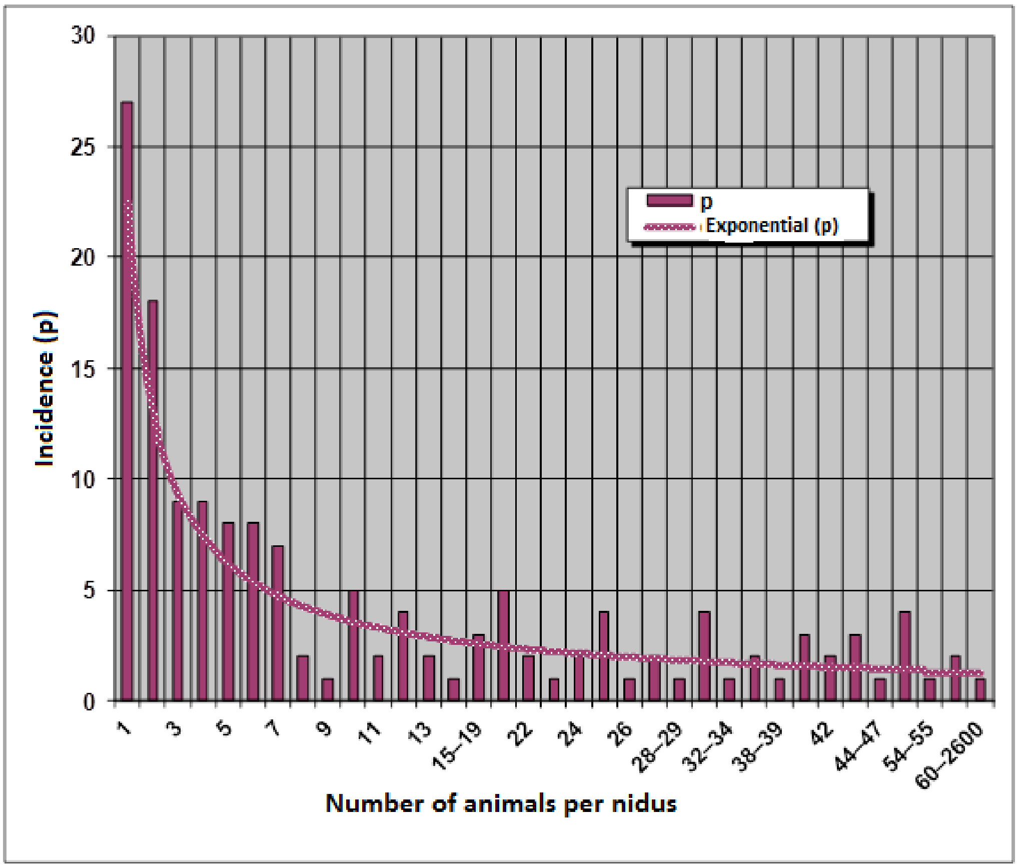

Fig. Typological scope of anthrax outbreaks – number of exposed animals in anthrax outbreaks globally, based on ProMED summarized data for 2007–2017 [4]

The index of nidality of infectious diseases confirms their most important epizootological features: sporadity or epidemicity; quantitative value of spatial spread in the nidus or its dead-end nature; contagiousness and transmission from diseased animals (source of direct infection) susceptible within the epizootological chain or absence of contagiousness, i.e. disability of diseased animals to be the source of infection.

It is widely accepted that anthrax epizootological process, as of a dead-end infection without direct chain transmission, is sporadic [1, 2, 3].

A detailed statistical analysis of the number of exposed animals in anthrax outbreaks globally, based on ProMED summarized data for 2007–2017 [4], was performed. Typological scope of anthrax outbreaks, number of exposed animals in the outbreaks and incidence are given in the following figure.

195 outbreaks/niduses globally were considered; n = 12,423 animals; 64 animals per nudus in average; widest limit range from min 1 to max 2,600. The biggest incidence (p) of anthrax (from 27 to 7) accounts for niduses, where the minimum number of animals were exposed (from 1 to 7).

To perform the quantification of anthrax nidality WAHIS data were used, as it is the most reliable source of statistical epizootological data [5].

Statistical data for Africa and Asia, contained by the System, are likely to be biased and non-reliable, as the numbers of exposed animals, both domestic and wild, are extremely high and reach tens of thousands. Based on the population characteristics of susceptible animals (meeting the feed demands) this implies a significant territory coverage of the nidus, which is unlikely when it comes to anthrax, being a natural-nidal infection reservoired locally in soils. Extremely high figures and spatial coverage of recorded mortality cannot itself reflect the true nature of contacts between susceptible animals and infection sources as well as the disease contagiousness, being its epizootological feature. Examples are given in Table 1.

Table 2 summarizes relatively collatable data of weekly animal anthrax reports in 2007–2017 in European countries and some adjacent affected countries based on WAHIS accepted format.

Summarized reported data are indicative of an extreme diversity of data about the number of exposed

Table 1
Summarized WAHIS data on animal anthrax in some African countries [5]

Country	Year	Number of outbreaks (niduses)	Number of exposed animals (in niduses)	Died
Zambia	2017	6	Cattle – 46,500	27
Lesoto	2011–2015	7	Total– 60,441, including cattle – 8,300, small ruminants – 50,000	65 55 2
Tanzania	2017	2	Total – 49,500, including cattle – 23,000, Small ruminants – 26,500	179 10 29
Uganda	2011	3	Wild animals – 33,116	144

Table 2
Summarized WAHIS reported data by countries, species, outbreak number and nature, mortality and index of nidality values [5]

Country	Species	Number of outbreaks (niduses)	Number of exposed animals (in niduses)	Average number of exposed animals per outbreak	Died	Index of nidality
England	Cattle	1	352	352	2	0.006
Germany	Cattle	4	264	66	16	0.06
Italy	Cattle	35	1,209	35*	44	0.04
	Small ruminants	38	2,694	71	26	0.01
	Horses	26	119	4.6	7	0.06
Poland	Horses	1	7	7	1	0.14
Romania	Cattle	5	37	7.4	7	0.19
	Small ruminants	4	306	77	13	0.04
	Horses	2	4	2	0	–
	Pigs	1	35	35	0	–
Serbia	Cattle	3	22	7.3	2	0.09
Slovakia	Cattle	5	537	107	13	0.02
Slovenia	Cattle	2	65	32.5	11	0.17
	Small ruminants	1	5	5	1	0.2
	Horses	**1**	**1**	**1**	**1**	**1.0**
Ukraine	Cattle	2	5	2.5	2	0.4
	Small ruminants	1	?	-	2	–
	Pigs	1	?	-	1	–
Finland	Cattle	1	36	36	1	0.03
France	Cattle	11	2,600	236	44	0.02
	Horses	1	2	2	0	–
Croatia	Cattle	5	73	15	6	0.08
	Horses	1	4	4	1	0.25
	Pigs	1	6	4	0	–
Switzerland	Cattle	1	80	80	1	0.01
Sweden	Cattle	13	703	54	47	0.07
	Small ruminants	1	11	11	1	0.09
	Horses	1	3	3	1	0.33
	Elks	1	?	-	3	–
Azerbaijan	Cattle	2	55	23	3	0.05
	Small ruminants	**1**	**645**	**645**	**1**	**0.002**
Armenia	**Cattle**	**1**	**1**	**1**	**1**	**1.0**
Kazakhstan	**Cattle**	**9**	**8,859**	**984**	**11**	**0.001**
	Small ruminants	**6**	**27,025**	**4,504**	**0**	**–**
	Horses	**8**	**2,698**	**337**	**2**	**0.0007**
	Pigs	1	181	181	0	–
	Camels	1	?	–	0	–
Israel	Cattle	3	641	214	10	0.02

*Values more than 10 are expressed in round numbers.

animals (in niduses) with limits from one to several thousands (Figure, Tables 1 and 2). This is preconditioned first of all by geography and husbandry practices. In economically developed European countries with moderate climate and small-sized groups of susceptible animals (from 1 to 10 exposed animals), several animals can be subjected to infection at the same time and the indices of nidality can be up to 1.0. In southern parts of Europe and adjacent infected countries, where free ranging is practiced, the number of exposed animals can reach tens of thousands, and the indices of nidality can be expressed in thousandths.

Table 3
WAHIS data with calculated mean values of the index of nidality by species

Species	Number of outbreaks (niduses)	Number of exposed animals (in niduses)	Average number of exposed animals per nidus	Died	Mean indices of nidality	Limits	
						min	max
Cattle	93	1,910	21	201	0.11	0.006	0.19
Small ruminants	46	3,016	131	53	0.04	0.01	0.20
Horses	32	139	4	10	0.07	0.06	0.33

That is why to obtain a relatively true systematization of the understanding of anthrax index of nidality based on the summarized data in Table 2, extreme values (1 and many thousands) of the outbreak size (marked in green), accepted as "popping-up" values, were excluded. Mean values of anthrax index of contagiousness for the most important domestic animals together with the original data are presented in Table 3.

Thus, values of the closest to reality anthrax indices of nidality, calculated using statistically reliable retrieved mean variants (number of outbreaks, exposed animals, mortality) for major species as percentage of infected animals per one outbreak, constitute 11% in average (from 0.6 to 19) for cattle, 4% (from 1 to 20) for small ruminants, 7% (from 6 to 33) for horses. This is entirely consistent with the most important epizootological signs of the disease, stereotypic for natural-nidal non-transmissive non-contagious saprozoonozes with soil reservoir and infection source, that is an immanent lethality, sporadicity, dead-end nature without contagiousness, horizontal transmission in the nidus and direct infection along the epizootological chains of susceptible animals from a diseased one, i.e. disability of the latter to be an infection source.

The highest incidence in the niduses with small number of animals present is likely associated with ordinary "technical" aspects of reporting and obviousness of livestock deaths exactly in small groups. On the other hand it can directly suggest spatial limitations, "spotting" of primary infection outbreaks and quantum occurrence of disease spontaneous cases.

Publication is prepared with the support of RUDN Program "5-100".

Conflict of interest: Authors claim no conflict of interest.

REFERENCES

1. Hypersporadicity of anthrax incidents [Gipersporadichnost' incidentov sibirskoj yazvy]. V. V. Makarov, M. N. Yamtitina, A. A. Shabeykin [et al.]. *Veterinariya*. 2019; 1: 22–27; DOI: 10.30896/0042-4846.2019.22.1.22-27 (in Russian).

2. Anthrax in humans and animals. *WHO*. 4th ed. Geneva, 2008; URL: http://apps.who.int/iris/bitstream/handle/10665/97503/9789241547536_eng.pdf (access date: 01.12.18).

3. Anthrax outbreaks: A warning for improved prevention, control and heightened awareness. S. Shadomy, A. El Idrissi, E. Raizman [et al.]. *Empres Watch*. 2016; URL: http://www.fao.org/3/a-i6124e.pdf (access date: 01.12.18).

4. Anthrax. *ProMED*. URL: http://www.promedmail.org.

5. World Animal Health Information System. *OIE*. URL: http://www.oie.int/wahis_2/public/wahid.php/Diseaseinformation/WI.

Submitted on 11.03.19
Approved for publication on 16.04.19