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Changes in Agent Variability and Time Course of Disease Incidence During a Year (As Exemplified by Dysentery)

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The vulnerability of epidemic process during the period of minimum annual incidence of the disease is validated. Biological properties of *Shigella sonnei* are studied and their variability examined using the index for evaluation of the mean number of variations for a sign. Minimum agent heterogeneity coincides with minimum incidence of disease and maximum heterogeneity with its seasonal rises.

Key Words: *epidemic process; dysentery; Shigella sonnei; heterogeneity of agent; minimal period*

High incidence of many infectious (including enteric) diseases in Russia necessitates the search for new approaches to investigation of the epidemic process and development of prophylactic measures. The biological basis (parasite system) and mechanisms maintaining its stability and resistance, the most important of which is the agent variability, attracts now much interest [1,2]. It is assumed that the system is stable when its elements and bonds between them reach the optimal level of variability. The higher is the variability, the more stable is the system, and vice versa [4].

As for the epidemic process, it can be assumed that the phase of low variability of components corresponds to minimum stability and resistance to external factors [5,6]. Since the parasite system includes only few species, the stability of epidemic process is determined by intraspecies variability of its subsystems, primarily the agent and host populations.

We studied the variability of the main biological properties of *Shigella sonnei* population during a year. This choice is explained by high incidence of dysentery, expressed many-year and annual rhythms, and good knowledge of its biological properties [7].

The purpose of this study was to distinguish the periods of the minimum and maximum variability of the agent and its correlations with annual incidence of Sonne dysentery.

MATERIALS AND METHODS

The following biological properties of *Sh. sonnei* isolated during different epidemic periods were studied: multiplication rate, antibiotic resistance, virulence, cytopathogenicity, biochemical characteristics, colicinotypes, adhesion, dissociative activity, and survival in tap water. All studies were performed using routine methods.

Variability was quantitatively assessed using an index estimating the mean number of variations of a sign by the formula:

$$\mu=(\sqrt{p_1}+\sqrt{p_2}+...+\sqrt{p_n})^2,$$

where n is the value of each species (morph), p is relative incidence, and μ is variability index.

Retrospective analysis of the incidence of Sonne dysentery in the Irkutsk region was carried out for 1975-1996, analysis of variability of colicinotypes and

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biovars for 1984-1996, analysis of other biological properties for one year.

RESULTS

The epidemic process of Sonne dysentery is characterized by clear-cut seasonal rhythms. At least half, and in some cases up to 90% of all cases in Irkutsk is registered during its seasonal rise. The incidence is minimum in March—May and maximum in August—November.

The annual variability of biological properties of *Sh. sonnei* is characterized by rhythmic changes. This allowed us to align the dynamic series obtained by estimation of the variability of *Sh. sonnei* colicinotypes for 1984-1996 with trigonometric functions (Fig. 1). Correlation coefficient for theoretical and actual variability was 0.42, indicating high reliability of the resultant curve (n=156, p<0.01).

Agent population variability by all studied biological characteristics correlated with the incidence of the disease during a year, which is well illustrated by comparison of the curves presenting disease incidence during the year and variability of the agent by colicinotypes (Fig. 2). According to the averaged many-year data, minimum heterogeneity of the agent coincides with minimum incidence of dysentery (February—June) and maximum with its seasonal peak (August—November).

Correlation coefficient for the mean monthly incidence of dysentery and population heterogeneity by biological characteristics was 0.70 (p<0.01 for colicinotype diversity) and 0.59 (p<0.05 for biovars), indicating a significant relationship between the studied phenomena during a year. The two parameters of variability (colicinotypes and biovars) strictly correlated (correlation coefficient 0.71, p<0.01). For other biological characteristics this regularity appeared as a trend.

Hence, analysis of phenotypical variability (heterogeneity) of *Sh. sonnei* population as an element of the epidemic process during a year helps distinguish the period of minimum stability of the agent and the time most favorable for attacking the studied biological system. The proposed approach suggests a new level of search for infection control methods, the key point of which is determination of the most vulnerable period in the epidemic process.

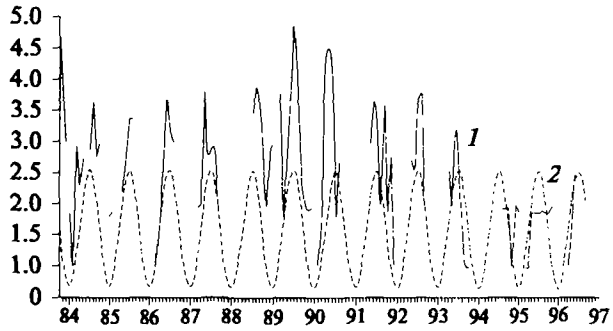

Fig. 1. Periodical function of variability of *Shigella sonnei* colicinotypes (April). *1*) actual data; *2*) theoretical curve.

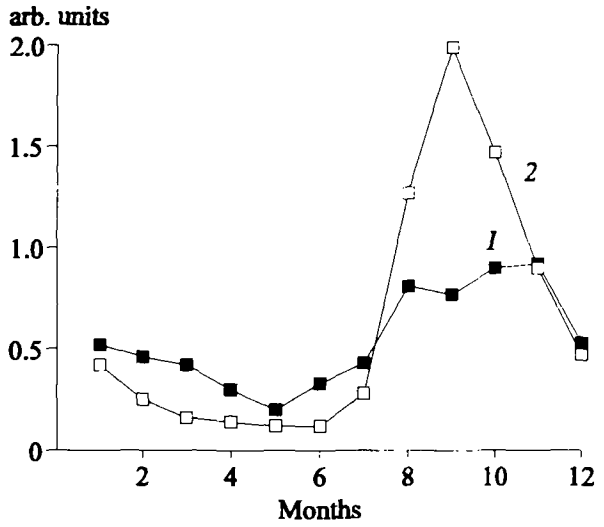

Fig. 2. Changes in the parasite population heterogeneity (colicinotypes) (*1*) and incidence of Sonne dysentery during the year (*2*, decreased 100-fold).

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