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Chapter 38

Estimation of the Role of Antropo-Zoonosis Invasion Agents in the Counteraction to Bioterrorism

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Abstract. As a result of investigations, the role of Coleoptera order of insects as reservoir hosts of helminthes of Strongylata and Rhabditata suborders was determined. It was proved that average quantity of helminthes revealed in accord with intensity and extensity of insect infection rate, has considerable advantage as compared with point estimation of larvae quantity in the environment. The offered method of larvae counting is very promising one, and it allows to use insects as an object of biological control over helminthes hazardous for humans and animals.

Keywords. Bioterrorism, helminthosis, insects, invasion, Strongylata, Rhabditata

38.1. Introduction

Traditionally it is assumed that action of biological weapons is based on using of disease-producing germs and toxins thereof. In a more comprehensive sense, infected transmitting agents, sources of infectious disease agents (arthropods and rodents) and injurious insects of agricultural plants are also referred to biological weapons [4]. Transmission method of biological weapon usage, which is connected with deliberate spreading of artificially infected blood-sucking insects and ticks, is known. This method is based on the fact that many arthropods easily take in certain causative agents of serious infectious diseases and retain them for a long time.

However, serious diseases can be also caused by helminthes, since their attack results in very complex mutual relations between two living organisms – parasite and host, and these relations tend to long-term or chronic course of disease. Parasites carry out their activity through trophic links (nutrition), which provide for high efficiency of their reproduction in evolutional and ecological aspects. Today the human life environment is drastically changed, as well as natural habitat of parasite spreading. Besides, cattle breeding technologies vary as well, and therefore, new transmitting organisms arise, which promote development and spreading of helminthes. In accord with WHO data, over 16 million fatal cases per year (about one third of all cases registered) are

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caused by infectious and parasitic (helminthic) diseases, which in accord with isolated classes of parasites are called nematodoses, trematodoses, cestodoses [5, 6]. In spite of "adherence" to warm and damp climate, helminthes are spread everywhere. Undoubtedly, helminthoses are found more often in the countries with undeveloped economy and improper financing of medical and social programs. In Europe, helminthes parasitize in every third citizen [7]. According to parasitological monitoring data, actually every resident of Ukraine is infected with helminthes at least once during his/her life. Annual incidence rate of helminthoses in Ukraine is 1,333 cases per 100,000 citizens. Information provided by regional sanitary and epidemiological stations and Ukrainian Center of sanitary and epidemiological supervision points out continuous growth of helminthoses' prevalence in Ukraine.

Helminthoses are characterized by wide range of clinical presentations: from asymptomatic to extremely severe ones, posing a threat to human life. Now about 300 species of helminthes, which can provoke diseases in humans, are known; in Ukraine there are nearly 25–30 parasites considered particularly hazardous. In accord with WHO data, over 4.5 billion people in the world are affected by parasitic diseases, and helminthoses account for 99% of all parasites [3]. There are too many reasons for inefficiency of counteraction to helminthoses in Ukraine.

1. Inadequate estimation of invasion impact on the level of human health and course of many somatic diseases, on the part of health departments
2. High level of contamination of the environment with helminth eggs as a result of discharge of un-treated effluents and wastewater of cattle-breeding farms
3. Uncontrolled migration of citizens
4. Growth in number of stray animals
5. Helminthoses prevention measures are limited to treatment of newly detected cases of disease only
6. Non-specific symptomatology of a number of helminthoses
7. Low awareness of standard methods of helminthological investigation for helminth eggs

Considerable part of people's and animals' parasitoses is of general nature (anthropozoonoses), their agents can develop both in human organism, and in animal one. Among potentially hazardous invasions, the most common forms are toxoplasmosis, opisthorchosis, echinococcosis, trichinosis, ascaridiasis, and strongyloidiasis [1].

However, reporting on helminth incidence rate is not put in order so far. First of all, it relates to helminthes parasitizing in domestic animals. Among them, rhabditatose-strongyloidiasis invasions prevail. Unfortunately, helminthoses do not fall into research domain of the majority of scientists, because of their low prevalence as compared with bacterial, viral, fungal, and protozoal infections in humans [4]. But nevertheless helminthoses pose a potential threat to public health of certain countries.

38.2. Methods

The area of investigations is Dnipropetrovsk region, located in steppe zone of Ukraine. The relief represents combination of ravines with water-parting aligned sections. Such

territories are divided by valleys of rivers-tributaries of Dnepr. Plain sections of water partings are used for ploughing-up. Cattle owned by private persons are freely grazing on natural pastures, located on hollow slopes and river valleys with meadow and steppe vegetation.

For studying the role of insects as reservoir hosts capable of transferring helminthes to various distances from the place of infection, the relevant investigations were carried out; such investigations included selection of insects on pastures, their dissection and determination of species of helminthes found therein. Estimation of epizootic situation as regards cattle helminthoses was made taking into account condition of pastures and rate of animals' grazing on them.

38.3. Results

38.3.1. Hazard of Helminthoses Invasions for Animals and Humans

In natural conditions of living, parasitism in animals remains in ecological balance: degree of invasion of certain representatives of helminthes makes 0.2–2.3%. As a result of impact of anthropogenic factor, sometimes all ruminant animals on pastures are affected by helminthes. The level of invasion in cattle is higher in spring-summer period than in autumn-winter one (Figure 38.1). At present time, there are a great number of pastures, which are unfavorable from the point of view of helminthoses, in Ukraine. Should cattle-breeding complexes be created for hundreds of animals, they are considered as "limited population", and rigid control over observance of veterinary and zoo-hygienic norms is provided. Quite often, falling of some species of helminthes into the said "limited population" leads to the necessity of slaughtering and industrial processing of all animals, thus causing material damage.

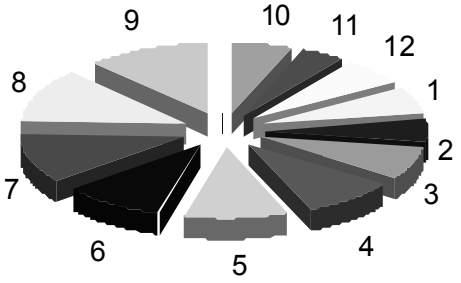

Figure 38.1. Annual dynamics of the level of helminthoses invasion in cattle from October 2002 till September 2003

In the process of evolution, a number of helminthes parasitized in invertebrates, then in vertebrates, and finally in humans. Evolution hadn't invented special human parasites; the same species of helminthes as observed in animals are typical for humans

as well. Human helminthoses are characterized by signs of chronic intoxication and allergization of the organism, impairment of functioning of immune system, respiratory apparatus, digestive tract, myalgia, lymphadenopathy, iron-deficiency anemia. As a result, health indices and quality of patients' life are reduced. Besides, helminthes are hazardous by their mechanical impact on human organism, and ability to induce serious complications such as obstruction of ducts of pancreato-biliary system, abscesses of liver and pancreas, perforation of intestines, and intestinal obstruction. Clinical diagnostics of helminthoses is rather difficult, since they more often display non-specific symptoms and syndromes: general weakness, headache, nervousness, sleep disturbance, local or systemic skin itch, shedding of hair, nail fragility, disturbance of appetite, transitory pain in stomach [8, 9]. Methods of laboratory examination adopted in the most of policlinics not always allow identifying parasites. Symptomatogy of the most parasitic diseases has low specificity. Clinical presentations are stipulated by long-term presence of the agent in the patient's organism (with no specific treatment provided), which is determined by duration of parasite life or frequent re-invasions, intensity of invasion and character of immune response of the patient. The following symptoms prevail: fatigability, deterioration of appetite, irritability, sleep disturbance, in children – mental and physical retardation. As a rule, general practitioners do not associate the above signs of organism asthenization with presence of parasites that in turn results in late and even incorrect diagnostics. Depression is often observed in case of prolonged course of intestines parasitosis, and "immersion in disease" is common [2, 3].

38.3.2. Ways of Spreading of Helminth Populations (Strongylata, Rhabditata), Role of Insects as Reservoir Hosts Thereof

Strongyloidiases and rhabditatoses are helminthoses arising as a result of parasitization of coelelminths of *Strongylata* and *Rhabditata* suborders. Depending on localization of causative agents in the host body, helminthes are divided into two groups. The first group includes nematodes, which parasitize in sexually mature stage in digestive apparatus, and the second group includes helminthes living in respiratory apparatus of animals and humans [9].

Mode of infection is as follows. Larvae of helminthes go out from eggs in the organism of diseased animal and with faeces get into the external environment, where they remain viable during 4–6 months, provided damp substrate is present. Together with feed, larvae are swallowed by invertebrates (earthworms), and they spend the winter and are maintained during droughty period in the above worms. No scientific papers about the role of insects in life cycle of the given group are available. At the same time, insects are one of the most numerous classes of animal world (in the aspect of species), and they can play the role of mechanical carriers of helminth larvae to various distances, increasing the risk of people infection with helminthoses.

The authors investigated the role of certain insect species in spreading of helminthes from territories of pastures to nearby settlements. Helminthes of Strongylata and Rhabditata suborders related to nematodes were taken as an object of investigation. Representatives of these helminth groups parasitize in digestive system and respiratory apparatus. In most cases, their main hosts are horses, pigs, birds, but often humans are also infected.

38.3.3. Results of Using the Method of Helminth Accounting with the Help of Insects – Reservoir Hosts

In the course of previous investigations it was found that epizootic situation is unfavorable as for helminthoses, and in particular – strongyloidiases and rhabditatoses [10]. Using the method of cultivation of coproscopic material of the cattle, larvae of seven species of helminthes of *Strongyloides* class (species *Strongyloides*, *Dictyocaulus*, *Bunostomum*, *Haemonchus*, *Oesophagostomum*, *Chabertia*, *Nematodirus*) were found. From three to six species of parasites fell at one animal. Most often (in 70–100% of cases) such species of helminthes as: *Bunostomum sp.*, *Haemonchus sp.*, *Strongyloides sp.* were detected. With a view to determining the insect role in the nematode development and spreading cycles, we took species which existence was connected with stay and development in cattle excrement. Hundred samples of each insect species from pastures of different areas of Dnipropetrovsk region were examined.

Investigations proved availability of larvae of these helminthes in the body of insects of Coleoptera order (*Oniticellus fulvus*, *Onthophagus ovatus*, *Onthophagus taurus*).This being the case, 20% of *Oniticellus fulvus* insects were infected with larvae of various nematode species. In 15% of them, larvae *Rhabditata* (*Strongyloides*), and in 5% – *Strongylata* (*Dictyocaulus*) were found. Larvae of *Strongyloides* (44%) and *Dictyocaulus* (24%) were revealed in 55% of examined *Onthophagus ovatus* insects.

No other St*rongylata* representatives or eggs of these helminthes were found. Maximum quantity of nematode larvae in each insect was equal to nine ones, and larvae of *Strongylata* greatly exceeded *Rhabditata* larvae in number (Figure 38.2).

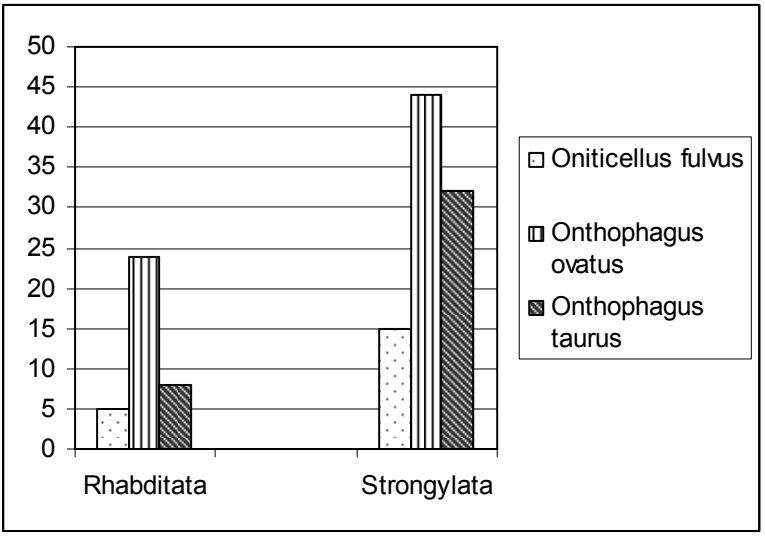

Figure 38.2. Indices of extensity of Coleoptera beetles infection with larvae of *Strongylata* and *Rhabditata* suborders (%) in conditions of Steppe zone of Ukraine (2007)

In the environment, larvae of nematodes of *Strongylata* suborder are developing during 8–16 days, depending on species. This phenomenon proves the fact that in fresh (1–3-day) cattle excrement no such helminthes were found, since they have not formed yet. Larvae *Dictyocaulus sp.*, which achieve invasiveness for 5–7 days, were revealed.

Results of the investigation show that the cattle, in conditions of steppe zone, is infected with mixed helminth invasion (seven nematode species of *Strongylata* and *Rhabditata* suborders). Representatives of insects of Coleoptera order, living in cattle excrement, are "reservoirs" of these nematode larvae and at the same time bioeliminators of their eggs. Coleoptera insects (*Oniticellus fulvus*, *Onthophagus ovatus*, *O. taurus*) are reservoir hosts in life cycle of nematodes – causative agents of helminthoses, promoting preservation of helminthes' invasion and their spreading on the territory of Ukraine.

Method of helminth accounting by examination of insect intestines is efficient and harmless one; it can be widely used for estimation of epizootic situation in certain regions of the country.

38.4. Conclusions

As a result of investigations, role of insects in preservation of the invasion source in the environment was confirmed, and their role in biology of helminthes representing Strongylata and Rhabditata suborders was determined.

Investigation of helminthes' species composition by revealing them in the insects proved to be an efficient method not requiring considerable material costs, having wide spectrum of action, and allowing precise determination of averaged indices of parasites' number. This method is harmless for humans and animals, and it is suitable for use in various natural and climatic regions.

Due to detailed study of biological peculiarities, and relations between helminthes and insects, the scientists can use insects as an indicator group, in particular, during estimation of prevalence of strongyloidiases and rhabditatoses.

Average quantity of helminthes found in accord with intensity and extensity of coprobiontic insects' infection rate, has considerable advantage as compared with point estimation of quantity of Strongylata and Rhabditata suborders' helminth larvae in soil.

Conducted investigations confirmed that further study of biology and mutual relations of helminthes and insects is very promising one, and it allows to use insects as objects of biological control over helminthes hazardous for humans and animals.

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