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STRONGYLOIDIASIS OF RUMINANTS OF THE STEPPE ZONE OF UKRAINE

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The monograph summarizes the data from the authors' research and Ukrainian and foreign publications about the peculiarities of the distribution of ruminant Strongyloides papillosus and the most widespread helminths on the territory of Ukraine. Consistent presentation of the material reveals the nature of the occurrence of strongyloidiasis and its spread. Methods for identifying Strongyloides papillosus that contribute to the qualitative differential diagnosis of ruminant helminths invasions are described.

Morpho functional changes in mammalian organs for strongyloidiasis, assessment of mutagenicity of the causative agent of strongyloidiasis, diagnosis, treatment, and prevention of strongyloidiasis are analyzed. The data presented are the basis for scientifically based control measures against strongyloidiasis.

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Chapter 1. SPREAD OF STRONGYLOIDOSIS OF FARM ANIMALS

1.1. Zonal distribution of *Strongyloides* in livestock farms of the steppe zone of Ukraine

Helminthiasis remains an urgent issue for Ukraine and many countries of the world [2, 3, 41, 172, 173]. Strongyloidiasis is considered one of the dangerous illnesses, the causative agents of which are highly pathogenic and well adapted both to parasitizing the body of various animals and humans, and to long-term existence in the environment [19, 35, 67, 124, 133]. Infestation caused by *Strongyloides stercoralis* (Bavay, 1876) in humans, was first described by Normand in 1876 under the name "Cochin-China diarrhea", and in 1882 Leuckart revealed the development cycle of its causative agent [96].

Strongyloidiasis of young cattle (causing agent – *Strongyloides papillosus* (Wedl, 1856) is widespread mainly in countries with a humid tropical and subtropical climate, to a lesser extent in the temperate climate zone [114]. However, it is registered both in America and in many European countries, Asian countries – Azerbaijan, Georgia, the North Caucasus, Moldova, etc. [5, 90, 102, 140].

The spread of strongyloidiasis to some extent depends on environmental factors that contribute to the preservation of the infestation in the environment [42, 112]. Among the most important factors are hydrometeorological conditions: humidity and air temperature. The development of eggs and larvae, migration of the last-mentioned in the soil and on the grass of pastures is ensured by the appropriate level of moisture. The wetter the soil in the pasture, the better the conditions for the development of invasive larvae, and the intensity of animal infection also depends on this [21, 137].

Global warming and the change in climatic conditions associated with it can certainly have a significant impact on the survival and spread of a number of helminthiases. The uneven distribution of strongyloidiasis in regions with a temperate climate is considered as microclimatic features characteristic of a specific region. According to the results of the research of M.A. Guzenko, O.V. Demkina in farms with different cattle

breeding systems in the Amur region, the level of strongyloidiasis ranged from 17.3 % to 90.6%. The dependence of the invasion of calves by the causative agent of strongyloidiasis on the conditions of their keeping was noted [68, 111].

Research about the spread of strongyloidiasis in calves in Ukraine is quite few and they concern more ecological aspects. Thus, some authors prove that the level of infection of animals by the causative agent of strongyloidiasis depends on the structure and physical and chemical composition of the soil of pastures, as well as the conditions of keeping in specific periods of the year [20]. One of the factors noted is the height of groundwater and the fact that staphylinid insects – *Philonthus longicornis* Stephens, 1832 and *Ph. spinipes* Sharp, 1874, play a certain role in the development cycle of rhabditids, which probably contribute to the spread of helminths as reservoir hosts [21].

The main mass of nematode larvae throughout the year is in the soil, on the roots of plants, where temperature, humidity, aeration can be kept optimal, even under extreme environmental conditions (drought, frost), this contributes to their preservation. O.O. Boyko in her previous work indicates that during wet periods of the year, a large number of larvae survive on the roots of plants in the soil. In addition to seasonal and weather fluctuations, the level of contamination of terrestrial pasture vegetation with nematode larvae is influenced by the type and number of animals that graze there, as well as soil moisture, vegetation yield, and its species characteristics [4, 22, 23].

In the conditions of Azerbaijan, the largest number of larvae is recorded in chestnut and light chestnut soil types [183]. In Ukraine, we did not find any reports on the distribution of larvae in different types of pasture soils. However, it is known that the number of eggs and larvae of nematodes (intestinal strongyles of livestock) the higher, the lower the salt content in the soils of contaminated pastures [22]. There are factors that contribute to the development and maintenance of invasive helminth larvae in pastures. Thus, the possibility of infection of animals during the grazing period depends on the concentration of invasive larvae on pastures. The presence and number of helminth eggs and larvae in the pasture, in turn, depends on the duration of grazing of infested animals and their number in a certain area. Abiotic factors play a decisive role in the process of development of invasive larvae: favorable climate conditions, weather conditions at different times of the year [107].

Eggs, larvae and helminths of free- living generations in the environment are not resistant to desiccation, high and low temperatures, insolation and disinfectants. However, with sufficient humidity, the invasive larvae can be stored for up to 2–3 months, creating a danger of infecting animals [53, 67]. Under unfavorable conditions, the larvae migrate into the soil, which can serve as a reservoir for them for a long time and from which the larvae constantly emerge on the grass. This happens more often in periods of drought, the larvae sink particularly deep into the soil, are preserved for a long time and, under favorable conditions, are able to reappear on the surface. Thus, invasive larvae of *Strongyloides* can survive in the soil for two winter seasons, therefore animals are infected not only by larvae of the current season, displaced by sick ones and parasite carriers in the spring, but also by larvae that have overwintered and are able to climb to the surface of the soil at a speed of 2–4 cm per day [99].

One of the features of the pathogen strongyloidiasis is that it develops well and is preserved in the conditions of livestock buildings [111, 167]. Infection of young animals occurs, as a rule, in the first days of life, through colostrum and milk of the parasite-carrying mother or when using mixed colostrum (from different cows) without prior pasteurization [60, 78, 98]. Often, the mass of strongyloidiasis among young animals is facilitated by the ability of larvae to penetrate through intact skin, more often during the period of stable keeping, rarely in walking yards. Separate data indicate that the maximum extent and intensity of strongyloidiasis infestation is recorded in the summer when animals are grazing on unhealthy meadows and pastures.

Strongyloidiasis is quite often registered among humans as well [59, 61, 95, 118]. According to E.A. Shablovska, the affected population in different regions of Ukraine ranges from 0.1 to 10%. More intense outbreaks of strongyloidiasis (from 6–7 to 100%) are registered in psychiatric hospitals, in boarding schools for mentally retarded children and elderly people, where due to violation of hygienic rules of their behavior, infection is possible both in the warm period of the year and in winter indoors. However, the low level of affected population usually does not reflect the real state of the epidemiological situation, since mass special examinations for strongyloidiasis are carried out too limited and therefore the indicators of infestation are based mainly on the results of clinical examination [95, 139].

The possibility of adaptation of the causative agent of human strongyloidiasis to the existence in the body of animals (dogs, cats, pigs) has been

experimentally established. At the same time, there are reports about the probability of infection of people from pigs and dogs, who have strongyloidiasis [150]. Strongyloidiasis is often registered in association with another helminthiasis. According to O.B. Grycik and V.A. Veselyi. intestinal strongylates are the most obvious associates in Ukraine strongyloidiasis in ruminants in the Steppe zone, during the summer grazing of livestock [57, 172]. At the same time, the level of infection of cattle by the causative agent of strongyloidiasis also depends on the characteristics of economic activity (technology of keeping animals, systems of grazing on natural and cultivated pastures). Thus, strongyloidiasis is a dangerous helminthiasis that is registered in young cattle all over the world. Infection of calves occurs, mainly, from sick mothers who are carriers of parasites through colostrum and milk, as well as percutaneously. The level of infestation of animals depends on the conditions of keeping, age and geographical and climatic factors. The causative agent of strongyloidiasis can be an associate of mixed infestations.

1.2. Morphological and biological features of causative agents of strongyloidiasis of animals

Strongyloidiasis in ruminants and rabbits is caused by nematodes of the species *S. papillosus* belonging to the family Strongyloididae. Parasitize only hermaphrodite females, which are localized in the surface layers of the mucous membrane of the small intestine, between the villi, under the epithelium [70, 92, 116]. According to the systematic position, Strongyloides belong to the type Nemathelminthes, class Nematoda, suborder Rhabditata. The generic name of the helminth comes from the Greek words: strongylos – round, eidos – shape. Strongyloides are also called intestinal eels [6, 21]. The causative agents of thrush and loidosis in young animals of various species have the veterinary importance: *S. papillosus* cause disease in ruminants and rabbits, *S. ransomi* – in pigs Schwartz and Alicata 1930, *S. westeri* Ihle, 1917 – in horses, *S. stercoralis* – in dogs, cats, as well as humans, *S. ovium* – in birds. The most pathogenic species are considered to be *S. ransom*i and *S. stercoralis*, whose parasitism is also possible in nonspecific hosts [106, 114, 176].

Parasitic females of Strongyloides are 3.5–6 mm long and 0.05–0.06 mm wide, thread-like body with a slender front end. According to K.I. Abuladze, the oral aperture of the parasitic generation Strongyloides is surrounded by two lateral lips, each of which is divided into three weakly expressed lobes, which bear a double circle of perioral papillae, four on

each. The esophagus is cylindrical in shape, the tail end is rounded or pointed. The opening of the vulva is located in the back half of the body and is surrounded by two cuticular thickenings (lips). Males of the free-living generation have a weakly expressed oral capsule, two equal spicules, a knob, and pre- and postnatal papillae at the tail end. Females have a graceful head end, in the uterus – 4–6 (2–8) eggs containing a formed larva. In the free-living generation, the esophagus has two expansions – in the front and back parts, and the front expansion is elongated, and the back has the appearance of a bulb armed with a valve apparatus [180]. Eggs of both generations have small size (0.04–0.06×0.02–0.03 mm), oval shape; covered with a thin shell, gray in color, by the time they are laid, they contain a formed larva.

Currently, two ways of exogenous development of free-living Strongyloides larvae are known: direct and indirect. This feature determines the uniqueness of the biology of these nematodes. Strongyloides are geohelminths. They are able to parasitize in the body of the host and lead a free lifestyle and reproduce outside the body. In the development of free-living larvae, rhabditid-like and filarial-like (invasive) stages are distinguished [67]. Following the direct path of development, rhabditid-like larvae differentiate into filarial-like one after 2–3 days. The indirect way of development of Strongyloides larvae lasts 4–7 days and occurs under favorable environmental conditions. At the same time, rhabditida-like larvae turn into males and females of the free- living generation. After fertilization, the female lays eggs about two days later, the same as a hermaphrodite parasite in the intestine of the host. In the environment, the preservation and development of new generations of Strongyloides larvae can continue for a long enough time.

Endogenous development begins with the entry of invasive larvae into the animal's body. This happens in different ways. The most common is alimentary, with water or feed, as well as when larvae are licked off the surface of the body. For keeping animals in unsanitary conditions, when feces contaminate the floor, bedding, larvae get on the fur and actively penetrate through intact skin. Information in literary sources also confirms the possibility of Strongyloides larvae getting to young animals through the milk of a parasite-carrying mother, as well as the possibility of in utero invasion [109, 113, 146, 157]. Having entered the animal's body by one of the possible ways or by several ways at the same time, which is more often observed, filaria-like larvae penetrate into the blood and lymphatic

vessels and enter the pulmonary capillaries. The cells migrate to the alveoli, interstitial tissue, bronchi, and trachea. Irritating the mucous membrane, they cause coughing, enter the oral cavity with mucus and are swallowed into the alimentary canal. In the small intestine, the larvae sink into the mucous membrane and reach sexual maturity after 5–8 days. The entire cycle of the development of blackheads into macroorganisms lasts approximately 7–14 days.

Some authors assure that there is a third way of development of Strongyloides – intra-intestinal, which is characterized by the transformation of rhabditid-like larvae into filarial ones directly in the intestine without their release into the environment. This path of development was described by K.I. Skryabin and G.F. Wagner back in 1924, experimentally confirmed and concerns the species *S. stercoralis*. Nishigori in 1927 established that auto invasion takes place if rhabditid-like larvae remain in the human intestine for more than 24 hours, for various reasons (long-term constipation, the presence of intestinal diverticulum, ulcerative lesions of the mucous membrane), which facilitates the penetration of filarial-like larvae into the intestinal wall [55]. About long-term, multi-year strongyloidiasis, as possible due to the simultaneous development of *S. stercoralis* in three ways reported by a number of researchers. The term of invasion of a person by strongyloidiasis can reach 20–30 years [96, 121, 139]. There are different opinions of scientists regarding the probability of parasitism of Strongyloides (species *S. papillosus*) in non-specific hosts: some consider it possible, others that the larvae can penetrate into the organism of a non-specific host, but they do not reach sexual maturity [72, 158, 163, 186].

Gugosyan et al. (2019) studied the morphological features of the free-living stages of development of *Strongyloides* spp., parasitizing in goat *Capra aegagrus hircus* (Linnaeus 1758) – *Strongyloides papillosus* (Wedl, 1856), horse *Equus ferus caballus* Linnaeus, 1758 – *S. westeri* Ihle, 1917, pig *Sus scrofa* Linnaeus, 1758 – *S. ransom* Schwartz & Alicata, 1930, dog *Canis lupus familiaris* Linnaeus, 1758 – *S. stercoralis* (Bavay, 1876). Larvae of the first stage according to body indicators length, total maximum body width, length of esophagus, length of intestine, length of tail end are significantly different in *S. papillosus* and *S. stercoralis* and for four of the previous five – in *S. westeri* and *S. stercoralis*. Larvae of the second stage also have a significant difference in all indicators studied by scientists in *S. papillosus* and *S. stercoralis*. According to the indices of the ratio total maximum body width to body length, length of esophagus to length of intestine, length of tail end to body length, length

of intestine to body length significant difference is noted in L_1 *S. papillosus* and *S. ransomi* , L_3 – *S. papillosus* and *S. westeri*, *S. westeri* and *S. ransomi*, in males – *S. papillosus* and *S. westeri*, *S. westeri* and *S. stercoralis, in S. papillosus* females and *S. westeri*, *S. papillosus* and *S. stercoralis*. In all species studied by scientists, the length ratio differed significantly of esophagus to length of intestine in third-stage larvae.

Boyko et al. (2019) also investigated the intraspecific morphological variability of *S. papillosus*. In laboratory conditions, *S. papillosus* was studied in guinea pigs, goats, and rabbits. As a result of the researchers' experiment, it was established that L_1 and L_2 *S. papillosus* have biggest size for everyone indicators in guinea pigs: for L_1 – body length and width, length esophagus and intestines; for L_2 – body width and intestine length. In L_3 *S. papillosus* by almost everyone by these indicators (except intestinal length) registered reliable difference parasites in the body of goats and rabbits. In rabbits and guinea pigs, as well as in goats and guinea pigs, the difference in these nematodes is determined by indicators width and length body. Males *S. papillosus* have differences in such hosts as goats and rabbits by all morphometric indicators, as well rabbits and guinea pigs. The non- parasitic form of females differs in large sizes in goats and rabbits. In *S. papillosus* goats registered the smallest most sizes morphological indicators. Vice versa the biggest dimensions determined in guinea pig larvae.

1.3. Pathogenetic processes in the body of ruminants with strongyloidiasis

In recent years, it has been noted in the literature that non-specific factors play the important role in the dynamics of pathogenesis and immunogenesis of helminth infections, and, first of all, allergic reactions that occur as a result of sensitization of the body in response to helminth infection [57, 96]. Helminth larvae that migrate in the body cause much more severe changes than those that develop in the alimentary canal without migration. Migrating through organs and tissues, Strongyloides larvae cause allergic phenomena, which are accompanied by the release of biologically active substances from the cells [165, 174]. For strongyloidiasis, especially during the larval migration period, growth of histamine in the blood was noted.

With percutaneous penetration of the larvae, the skin (especially the udder, in the groin, nose, mouth, anus, and intercalary space) develops the phenomena of allergic dermatitis in the form of acute hyperemia, diapede-

sis hemorrhages, edema, tissue eosinophilia, lymphoid plasmocytic reaction. Then the skin thickens, becomes wrinkled, numerous small blisters filled with transparent or cloudy liquid appear. These processes cause itching. In the lungs of calves infected in the first hours and days of life, already on the 7th day, acute hyperemia, massive hemorrhages, alveolitis , small focal atelectasis, emphysema, cellular perivascular and peri bronchial proliferate. After 10 days, the reaction intensifies. The eosinophilic reaction is especially noticeable, which is known to be an important criterion of the allergic state of the body for helminth infections [71, 87].

Changes characteristic of acute catarrhal enteritis develop in the small intestine, larvae and sexually mature helminths cause a complex set of pathological changes. The mucous membrane is swollen, dotted and striped hemorrhages are visible under the mucus. In places, in in the form of small foci, the mucous membrane is covered with whitish layers (as if sprinkled with semolina), which cannot be removed. These are foci of necrosis. Sometimes small whitish dense nodules containing larvae can be found [86, 143, 184]. Catarrhal destructive necrotic, atrophic enteritis develops, which lead to the loss of the functional capacity of the mucous membrane and its replacement by connective tissue. Mesenteric and regional lymph nodes are also reactive. During histological examination, larvae are found in them, around which granulomas are formed. In addition, pronounced follicular hyperplasia, plasmacytic reaction, eosinophilia, and serous edema are noticeable [184].

In natural conditions, when animals are repeatedly infected with helminths, migrating larvae cause more significant changes in the intestinal mucosa – peeling, atrophy and desquamation of the epithelium. In the future – proliferation of connective tissue cells, sprouting of the mucous membrane by connective tissue fibers and scarring of defects. The function of such a mucous membrane of the intestines is sharply disturbed, causes diarrhea, the animal loses weight and often dies [17, 55, 64]. In the lungs, if the animal died during larval migration, characteristic changes are observed. The sharp edges of the diaphragmatic lobes are dull, of a pasty consistency. Numerous hemorrhages of different sizes are visible under the pleura on the lungs. The largest number of hemorrhages is detected in the apical and cardiac lobes of both lungs, as well as in the cranial part of the diaphragmatic lobes. In addition to hemorrhages in the lungs, strongyloidiasis is characterized by numerous foci of atelectasis. They are compacted, dark red in color, somewhat bluish. In the lungs, it is possible to detect

pink-white crippling foci of compensatory emphysema. [70]. In the liver and kidneys, small whitish-gray foci are visible under the capsule. The liver is usually full of blood [184].

It has been experimentally proven that strongyloidiasis causes changes in the immune system of infected animals [57, 74, 179]. Already on the 7th day after the introduction of the pathogen, the infected lambs showed changes in the indicators of non-specific resistance of the body: the activity of the blood serum complement and the level of natural antibodies decreased, while in healthy animals, during the entire experiment, a gradual increase in these indicators was noted. Significant changes in the separation of blood fractions testified to an active immune reaction in the body of animals under the influence of helminthiasis: the level of albumins decreased, while the level of globulins increased. The highest titer of antibodies was detected in the third week after infection, which indicated active immune processes in the body [57, 161].

Any substances foreign to cells and the body are pathogenic factors. The secretory-excretory products of life activity of helminths are unnatural for the host's body and its physiological processes. The influence of parasite products is not limited to the organs and tissues in which they are localized – changes occur in the structure and functions of the host's entire organism [7, 84]. Currently, the term parasite metabolites are most often used to define the secretory-excretory and somatic products of helminths [89, 91]. Metabolites in the host's body are transported by blood, lymph, and tissue fluid.

One of the most important genetic aspects of the relationship in the parasite-host system is considered to be the mutagenic effect of the parasite on the hereditary apparatus of the host's somatic and generative cells. In mammalian cells, mutagens can cause DNA molecule damage (gene mutations), chromosomal rearrangements (aberrations), recombination and genomic mutations. The mutagenic potential of viruses, bacteria and protozoa is an undeniable consequence of their close contact with the nuclear apparatus of mammalian cells and their ability to directly influence it. The size of helminths does not allow them to contact the nuclear apparatus of the host's cells, but the products of their vital activity have this ability. Analysis of the influence of relationships in the parasitic system can be carried out not only at the level of the organism, organ or cell, but also at the molecular level [54, 80, 104].

Cytogenetic methods are sensitive enough to establish the mutagenic influence of environmental factors. With their help, it is possible to register

changes at the chromosomal and genomic levels of the organization of hereditary information [119]. Accounting for damage to the DNA molecule, which is a consequence of the action of genotoxic factors in the environment in prokaryotes and eukaryotes, is carried out using methods of assessing the integrity of the double- stranded polymer structure of DNA, registration of modified DNA bases, accounting for marked bases included in macromolecules during damage repair [152, 154]. Gel electrophoresis of individual cells is considered the most modern, promising and sensitive method of detecting primary damage to the DNA molecule of individual cells under the influence of environmental factors – " Comet assay" or the "DNA-comet" method [77, 115].

One of the cytogenetic methods of rapid assessment of the genetic danger of xenobiotics *in vivo* in mammals there is a micronucleus test. This method has been widely used in human and veterinary medicine to determine the mutagenic effect of environmental factors and is recommended by the International Environmental Protection Agency as a highly sensitive method for detecting mutagens and carcinogens [40, 48, 79, 151]. Micronuclei were first discovered in erythrocytes. They are elements of nuclear (chromatin) origin, usually small rounded formations colored in the tone of chromatin. They are classified into small, medium and large.

Micronuclear test in somatic cells as a screening test proposed in 1975–1976 to study the effect of environmental factors on bone marrow and peripheral blood cells [134, 135]. The use of the test allows differentiation of clastogenic (formation of small micronuclei from chromosome fragments) and aneugenic (formation of medium and large micronuclei from individual chromosomes or groups of chromosomes) effects of environmental factors. The influence of helminths on the indicators of the micronucleus test in infested animals began to be studied already in the previous century. With the use of the micronucleus test in the bone marrow of experimental animals, the facts of the mutagenic effect of metabolites of nematodes (*Ascaris suum* Goeze, 1782) on the somatic cells of the host [153]. Thus, experimental studies of the mutagenic effect of migrating ascaris larvae on the hereditary apparatus of pigs proved that the number of chromatid aberrations increased by 2.25 times, compared to the values of the control group. Under these conditions, it was found that the percentage of cells with changes in polyploid chromosomes was increased in 1.75 times in infected piglets on the 21st day after infection. Based on the obtained data, it was concluded that migratory ascariasis is accompanied

by an increase in the level of chromosome aberration in the peripheral blood lymphocytes of piglets from the 7th to the 21st day after infection [9, 110, 153].

Invasion by trichuris – *Trichuris* (*Trichocephalus*) *muris* (Schrank, 1788) causes increased levels of chromosomal and genomic mutations in bone marrow cells of white outbred mice [151]. According to the results of experimental studies, the author found that the metabolites released by Trichuris have a mutagenic effect on the chromosomal sets of the host cells and cause a probable increase in the number of chromosomal aberrations in the bone marrow cells of white mice. In the infested in mice, the number of cells of the lymphoid series with a violation of the structure (chromosomal and chromatid breaks) and the number of hypo- and hyperploid chromosomes increased. At the same time, the most significant violations in the chromosomal apparatus were established on the 30th and 40th day of invasion, which coincided with the term and peak of the growth of micronucleus test indicators. Significant violations were noted with a larger amount of introduced invasive material to laboratory animals (42 eggs/g of body weight) [49, 120, 151].

Thus, the pathogenic effect of strogiloides on the animal body is accompanied by mechanical injury of organ tissues along the migration paths of larvae and in the place of parasitism of hermaphrodite females and the occurrence of inflammatory reactions, intoxication, mutagenic effects, as well as an immune reaction of the body. The degree of damage to the organism of susceptible animals and the nature of pathogenic changes depends on the intensity of the invasion, the general physiological state and the conditions of keeping. Cytogenetic changes in the chromosomal sets of the host's somatic cells were found to be most significant during the biological activity of the parasites (migration and molting of larvae, reaching sexual maturity and maximum size). For significant spread helminthiasis in animals are possible changes in hereditary device somatic and generative cells _ These questions are important in studying the pathogenesis of helminths diseases and diagnostics, now remain understudied and still relevant. Therefore, strongyloidiasis is a widespread helminthiasis that is registered in various countries of the world and has not only epizootological, but also epidemiological significance [19, 35, 68, 95, 124, 139].

S. papillosus , the causative agent of strongyloidiasis in young cattle, is a small nematode (3.5–6 mm) localized in the small intestine. Strongyloides develop according to the type of heterogony – the change of parasitic

and free-living generations. Under such biology, a hermaphroditic female is a parasite in the animal's body, and free-living stages of different sexes develop in the environment, which are capable of reproduction under favorable conditions. Strongyloides larvae become invasive 2-3 days after hatching [47, 106]. Animals are infected with invasive (filaria-like) larvae alimentary and percutaneously. The authors also claim the possibility of in utero entry of larvae. Their development to the sexually mature stage in the body of animals lasts 7–14 days [105, 157, 171]. During this time, the larvae migrate through the tissues and organs of the animal body, causing pathogenic changes. Animals develop enteritis, pneumonia, cell destruction, and dysfunction of internal organs, which often causes their death at a high intensity of infestation [101, 108, 109].

Mutagenic effect on the hereditary apparatus of somatic and generative cells is considered one of the important aspects of the influence of parasites on the animal body. In mammalian cells, mutagens (secretory-excretory products of the vital activity of parasites) can cause DNA molecule damage, chromosomal rearrangements, recombination and genomic mutations. The micronucleus test is now a cytogenetic method for rapid assessment of the genetic danger of xenobiotics in mammals [84, 129]. Its use on the bone marrow of experimental animals has established the facts of the mutagenic effect of metabolites of cestodes (*Taenia solium* Linnaeus, 1758, *Hymenolepis nana* (Von Siebold, 1852) and nematodes (*A. suum, Toxocara canis* (Werner, 1782), *Trichinella spiralis* (Owen, 1835) on the somatic cells of the host [79, 155], which made it possible to assert their pathogenic effect. These questions are important not only in the study of the pathogenesis of helminthic diseases, but also in their diagnosis. Currently, they remain insufficiently studied and relevant.

When diagnosing strongyloidiasis, the epizootic situation, clinical signs and results of coproovoscopic studies are taken into account. For laboratory research, flotation methods are recommended: according to Fülleborn, Kotelnikov-Khrenov or Shcherbovych which use saturated solutions of salts with a density of not less than 1.2. Eggs *of S. papillosus* are easy to recognize by their shape and presence of larvae. In stale samples of feces, or during their cultivation in laboratory conditions, rhabditid-like larvae of Strongyloides are found, which have one or two extensions on the esophagus, which allows them to be differentiated from the larvae of other nematodes [126, 127, 138]. Clinical manifestations of strongyloidiasis are uncharacteristic. With a low infestation of animals, the disease can be as-

ymptomatic; in case of a significant invasion, the clinical signs are similar to those of enteritis of infectious or non-infectious etiology, which should be taken into account when making a diagnosis. Quantitative counting of helminth eggs in 1g of feces makes it possible to find out the level of infestation of animals. There are different methods of counting eggs [62, 123, 164, 170]. For postmortem diagnosis of strongyloidiasis take into account pathological-anatomical and histological changes of organs and tissues. In animals suffering from strongyloidiasis, mechanical disease is noted the effect of parasites in intestinal tissues, regional lymph nodes, lungs [184]. At the same time, scientists prove the toxic and mutagenic effect of helminthiasis pathogens on the body of infested animals [156]. It has been experimentally proven that strongyloidiasis causes changes in the immune system of infected animals as well [57].

In recent years, more and more attention has been paid to the issue of active immunization of animals as prevention of helminthiasis. With its solution, it will be possible to solve a number of problems related to helminthiasis in animal husbandry. For this, it is necessary to study the mechanisms of allergy and immunity during invasive diseases [2, 8]. Successful fight against invasive diseases is possible only if highly effective medicines are available. Currently, the market of veterinary drugs presents and confirms the high effectiveness of anthelmintics – derivatives of the chemical groups of benzimidazole, avermectin and imidothiazole , which show a different mechanism of action on nematodes [16, 38].

Researchers have convincingly proven their effect on parasites, but at the same time, in some cases, the suppressive effect of anthelmintic drugs on the animal body is emphasized. That is, at the same time as being highly effective, anthelmintic drugs can negatively affect hematopoiesis and cellular factors of immunity [57, 58]. The immunosuppressive effect of albendazole, fenbendazole, and tetramizole has been experimentally confirmed in the practice of human and veterinary medicine [13, 63]. It has been proven that immunosuppression creates conditions in the body that contribute to the complication of helminthiasis with diseases of an associative nature, multiple super- and reinvasions [1, 102]. Taking into account these data, a number of authors recommend simultaneously with anthelmintics to carry out symptomatic treatment and use vitamins, immunomodulators to strengthen the immune status of the animal body, restore digestion, and promote the prevention of intestinal helminthiasis [69]. Therefore, strongyloidiasis is a dangerous helminthiasis that has a significant distribution

in the world. For many years, the study of its epizootology, biological features and pathogenesis of the pathogen has not diminished the relevance of the issue. New, little-studied areas have appeared in the understanding of the pathogenic properties of parasites, which were not revealed for Strongyloides. It remains important to develop and implement scientifically based effective methods of diagnosis and treatment of strongyloidiasis in animals.

Chapter 2. EPISOTOTIC SITUATION REGARDING STRONGYLOIDOSIS OF RUMINANTS IN CONDITIONS OF STEPPE AREA OF UKRAINE

2.1. Associative invasions of ruminants in conditions of steppe zone of Ukraine

The natural and climatic conditions of the steppe zone of Ukraine are favorable for the development of the livestock sector of agriculture. However, it is they, as well as weather conditions, that are often, at the same time, those dangerous factors that create conditions for the preservation of invasive elements of helminths in the environment. During the study of the epizootic situation regarding strongyloidiasis of animals, considerable attention is paid to its distribution, the degree of animal damage depending on the age, period of the year, and the method of keeping. The environment (soil of pastures and bedding of livestock premises) plays a major role in the preservation of invasive larvae of *Strongyloides*. The helminthological situation in the territory of the Dnipropetrovsk region in cattle breeding farms of various forms of ownership and management technology is quite tense. According to the reporting documentation of the Main Department of Veterinary Medicine in the Dnipropetrovsk region, during 2009–201, district veterinary medicine laboratories examined 21,223 animals for helminthiasis. According to the results of the conducted research, livestock farms in certain regions of the region were recognized as unfavorable in terms of fasciolosis, dictyocaulosis and gastrointestinal strongylatoses, as well as neoascarosis and strongyloidiasis of young cattle (Fig. 2.1).

Affected cattle by helminthiasis in the period 2009–2011 was different, depending on the age of the animals, natural climate and weather conditions, as well as the system of keeping and feeding. Selective monitoring for three years confirmed the highest level of infestation of cattle in 2009 of gastrointestinal strongylatoses – 46.7%. Neoascarosis of calves had significant fluctuations in the infestation level over the years: they were quite high in 2009 and 2011 (40.1 and 42.7%) and slightly lower – 18.8% in 2010. Indicators of strongyloidiasis were consistently low, but with a growing tendency. Yes, this disease was not registered in 2009, but in the following

two years, young cattle were affected by it in 9.7 and 10.1%. The lowest with regard to the level of infestation of livestock were the indicators of dictyocaulosis, by year they were 2.5, 4.8, and 2.5%, respectively.

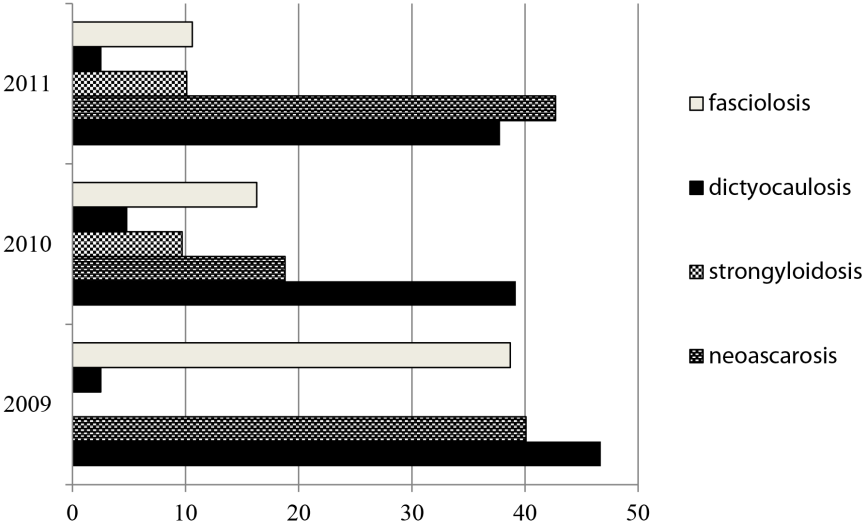


Fig. 2.1. Distribution of helminthiasis of cattle in farms of the Dnipropetrovsk region (extent of infestation, %)

The highest rates of fasciolosis in the farms of the Dnipropetrovsk region were recorded in 2009 – 38.7%, in the following two years they decreased and amounted to 16.3 and 10.6%, respectively, which can probably be explained by hot weather conditions. In the section of regions, the highest extent of infestation was recorded in cattle of gastrointestinal strongylatoses in the Kryvyi Rig district, its indicators here amounted to 63.6%. A low level of infestation of animals by the causative agent of dictyocaulosis was noted in Synelnykove district – 3.9%. Fasciolosis was most often registered in livestock of the Novomoskovsk district (48.9%), and in the Sofiyivka and Pyatyhatky districts – 8.9 and 2.1%, respectively. Neoascarosis of calves, according to district veterinary medicine laboratories, was registered in farms of only five districts of the region. At the same time, the highest level of damage was noted in the farms of Kryvyi Rig district, namely: 29.8%, the indicators were much lower in animals of Pyatyhatky (12.7%) and Verhniodniprovsk (11.2%) districts. They turned out to be the lowest in calves from farms Sofiivka district (10.3%).

Strongyloidiasis was registered in 2009 and 2010 only in the farms of Pyatyhatky and Tsarychanka districts. The extent of the invasion over two years was in averaged 9.9%. However, we failed to reliably and fully establish the features and regularities of the regional course of the epizootic process of helminthiasis in cattle in the territory of the Dnipropetrovsk region, since the data of the systematic monitoring of the invasive situation in the veterinary reporting turned out to be insufficient. In addition, a sharp decrease in the number of livestock in the farms of the region and a reduction in the total number of planned helminthological research by veterinary medicine laboratories in 2009–2011 do not give confidence in the reality of the results shown.

Yes, only research on fasciolosis and gastrointestinal strongylatoses in cattle covered farms of all 22 districts of Dnipropetrovsk region. As for other helminth infections, it was possible to monitor the situation only in some of its districts. Strongyloidiasis was not registered as a stationary infestation in any of the districts of the Dnipropetrovsk region in the reports of the district departments of veterinary medicine. We were also unable to obtain complete data on the spread of this infestation in the Scientific and Research Institute on Center Laboratory Diagnostics and Veterinary and Sanitary Expertise of Ukraine. In the fall and winter of 2009, helminthological studies of cattle were conducted in 14 farms in nine districts of the Dnipropetrovsk region. Fecal samples were taken from animals of different ages, taking into account clinical signs, housing conditions and the possibility of helminth infection. The level of infestation of livestock and types of helminthiases is shown in Table 2.1. In total out of 178 animals examined coproscopically, 109 were affected by helminthiasis, which was 61.2%. In the farms of Dnipropetrovsk, Pyatyhatky and Synelnykove districts, the incidence of livestock was higher than in other districts and reached 85.3, 76.2, 64.3% in accordance.

It should be noted that strongyloidiasis as a monoinvasion was registered only in calves up to 5–6 months of age. In other age groups, as a rule, this invasion was noted as mixed, most often with gastrointestinal strongylatoses. According to our research, the extensiveness of Strogylosis infestation in young cattle from farms in the Dnipropetrovsk region was the highest and reached 72.4%, in Pyatyhatky – 56.3%, and Kryvyi Rig – 45.5%. The lowest extent of infestation was recorded in calves of the Pavlograd and Synelnykove districts – 33.3 and 11.1%, respectively. At the same time, this disease has not been registered in the Novomoskovsk district.

Table 2.1

Invasion extent and species composition of cattle helminths in farms of Dnipropetrovsk region for 2009

Districts	Researched animals			Identified helminth infections											
	total	Among them them with invasion	%	monoinvasion								mixed infestations			
				strongyloidosis		fasciolosis		neoascarosis		dictyocaulosis		gastrointestinal strongylatoses		gastrointestinal strongylatoses + strongyloidosis	
				animals	%	animals	%	animals	%	animals	%	animals	%	animals	%
Dnipropetrovsk	34	29	85,3	21	72,4	2	6,9	2	6,9	0	0,0	4	13,8	0	0,0
Novomoskovsk	10	4	40,0	0	0,0	3	75,0	0	0,0	0	0,0	1	25,0	0	0,0
Synelnykove	14	9	64,3	1	11,1	2	22,2	0	0,0	1	11,1	3	33,3	2	22,2
Upper Dnieper	19	7	36,8	3	42,9	0	0,0	1	14,3	0	0,0	2	28,6	1	14,3
Sofiivka	23	11	47,8	7	63,7	1	9,1	1	9,1	0	0,0	2	18,2	0	0,0
Yuryivka	21	13	61,9	5	38,5	3	23,1	0	0,0	4	30,8	0	0,0	1	7,7
Pyatyhatky	21	16	90,5	9	56,3	1	6,3	2	12,5	0	0,0	2	12,5	3	18,8
Kryvyi Rig	20	11	55,0	5	45,5	0	0,0	2	18,2	0	0,0	4	36,4	0	0,0
Pavlograd	16	9	56,3	3	33,3	3	33,3	0	0,0	3	33,3	0	0,0	0	0,0
In total	178	109	61,2	54	49,5	15	13,8	8	7,3	8	7,3	18	16,5	7	6,4

Neoascarosis of young cattle was more often noted in farms of Kryvyi Rig district (18.2%) and less – 9.1 and 6.9% in Sofiivka and Dnipropetrovsk. Dictyocaulosis was confirmed in three districts of Dnipropetrovsk region: Pavlograd, Yuryivka, and Synelnykove. The highest rate of dictyocaulosis was in farms of the Pavlograd district and amounted to 33.3%. In the other two districts – 30.8 and 11.1%, respectively.

Fasciolosis was registered in 13.8% of the studied animals. The highest rates of cattle affected by this infestation were in Novomoskovsk district (75%) and were not registered in Kryvyi Rig and Verhniodiprovsk ones. Low rates of fasciolosis (6.8%) were found in animals of Pyatyhatky district. Most often, ruminant helminths are noted in the association strongilatosis and strongylatosis-strongyloidosis infestation (on average 16.5 and 6.4%, respectively), especially in those farms where stall-walking animals are kept. In Kryvyi Rig gastrointestinal strongylatoses accounted for 36.4%. At the same time, strongyloidosis-strongyloidiasis infestation was the highest in Sinelnykove district of Dnipropetrovsk region – 22.2%.

According to the results of research in the territory of the steppe Prydniprovya (in particular, the Dnipropetrovsk region) in the groups of nematodes of the suborders Strongylata (order Strongylida) of cattle the next species were registered: *Bunostomum phlebotomum* (Railliet, 1900), *Chabertia lamb* (Fabricius, 1794), Dictyocaulus viviparous (Bloch, 1782), *Haemonchus sp.*, *Oesophagostomum sp.*, Nematodirus sp. At the same time, B. phlebotomum and S. papillosus dominated in the groups of strongylids and rhabditids in the territory of the Dnipropetrovsk region.

The greatest species diversity in the Strongylida and Rhabditida groups of livestock in the external environment was noted in the summer period (Fig. 2.2). The maximum indexes of biological diversity in the Dnipropetrovsk region were noted in the samples from Petrykivka and Novomoskovsk districts, where six and seven species of nematodes were registered, respectively. The lowest indicators of biodiversity were found in the Dnipro district.

According to research results, strongyloidosis and neoascarosis, as monoinvasions, were detected in calves under one year of age, starting from 1.5–2 months of age. Calves aged 3–4 months were most affected by the causative agent of strongyloidosis. In animals 5–6 months old and older, mixed helminthiasis was registered, the associates of which, in addition to those mentioned, were gastrointestinal strongylatoses. Strongylatosis of the respiratory organs (dictyocaulosis) was also diagnosed in some farms, but

at the time of research, such cases were insignificant, so they were not taken into account. Therefore, the analysis of the reports of the main department of veterinary medicine in the Dnipropetrovsk region and the results of our own research made it possible to establish a significant spread of helminthiasis in cattle and the presence of separate stationary foci in the territory of the Dnipropetrovsk region. In particular, the presence of strongyloidiasis was confirmed and the level of infestation with this helminthiasis in cattle of different ages under different types of keeping was determined.

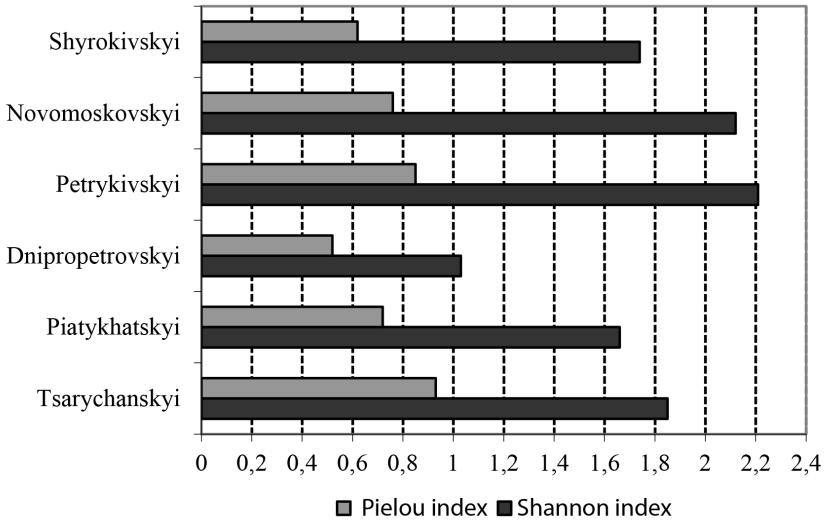


Fig. 2.2. Diversity of complexes of Strongylida and S. papillosus larva in livestock on the territory of the steppe Prydniprovya in 2007

At the territory of Dnipropetrovsk region, 10 species of helminths have been registered in small cattle, in particular sheep and goats [24]: 6 species of Nematoda, 2 – Trematoda and 2 – Cestoda. Among the defined helminths of the Nematoda class 4 parasites of the gastrointestinal tract (*Nematodirus* sp., *H. contortus* Rundolphi 1802, *Trichuris* s., *S. papillosus*) and 2 ones of respiratory tract (*Muellerius sp., Protostrongylus sp.*). Trematoda represented by *Fasciola hepatica* Linnaeus, 1758 and *Dicrocelium lanceatum* Stiles et Hassall, 1896. Among the helminths of the Cestoda class, *Moniezia expansa* (Rudolphi, 1810) and *M. benedeni* (Moniez, 1879) was identified. The dominant species among helminths of small ruminants is the nematode *H. contortus* (Fig. 2.3).

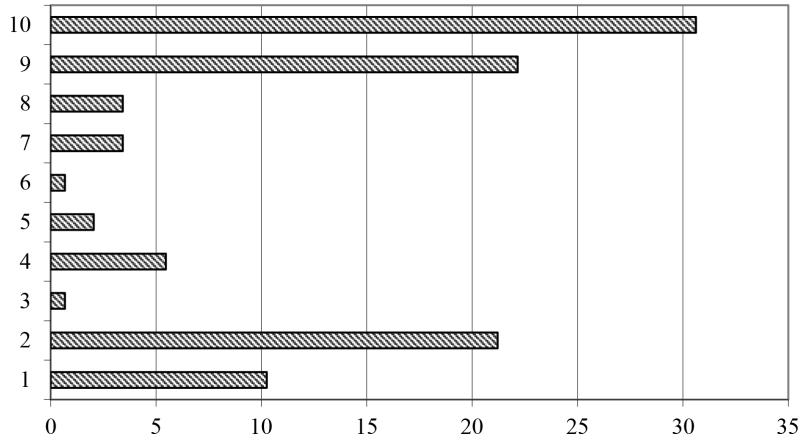


Fig. 2.3. Species composition of groups of nematodes of small ungulates in the Dnipropetrovsk region (share in the group, %): 1 – *M. expansa;* 2 – *M. benedeni;* 3 – *F. hepatica*; 4 – *D. lanceatum*; 5 – *Nematodirus* sp.; 6 – *Trichuris* sp.; 7 – *Protostrongylus* sp.; 8 – *Muellerius* sp.; 9 – *S. papillosus*; 10 – *H. contortus*

The smallest share in the group of helminths of small cattle is *F. hepatica* and *Trichuris* sp. At the same time, the highest indices of biological diversity were noted in samples of coproscopic material taken from sheep and goats consuming pasture vegetation from May to September (ten species of helminths from three classes were registered) (Fig. 2.4).

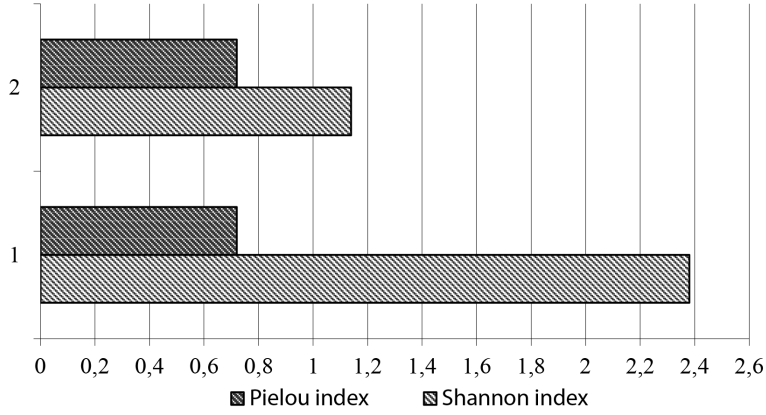


Fig. 2.4. Species diversity of helminths of small ungulates of the Dnipropetrovsk region: 1 – with grazing; 2 – for keeping in the premises

2.2. Age and seasonal dynamics of strongyloidiasis in animals

The results of the research showed that most often in the external environment the eggs of S. papillosus were isolated from the feces of cattle aged up to one year, less often – aged from five to seven years. Strongyloidiasis in calves is registered starting from the age of 1.5–2 months, which indicates the probability of their infection in utero and in the first days of life through colostrum and, at the same time, the presence of individual characteristics in the immune protection of their body.

Research has established that depending on the age of the animals, the level of strongyloidiasis is different. Fluctuations in infestation of animals aged from one month to two years and older are given in Table 2. 2.

Table 2.2

The level of infection with the causative agent of strongyloidiasis of cattle in APE Chumaky, Dnipro district, x ± SE, n = 10

Age of animals, months	Number affected	Invasion extent, %	Intensity of infestation, eggs/g of feces
1–2	4	40	11.7 ± 1,5
3–4	10	100	31.6 ± 1.1
6-12	8	80	23.3 ± 0.8
Elder then 24 months	5	50	12.6 ± 0.8
In total	27	–	–
On average	–	68	19.8 ± 1.1

As can be seen from the table, the maximum infestation by the causative agent of strongyloidiasis was registered in calves aged 3–4 months. The extent of infestation in animals of this age group was 100%, with the intensity of infestation – 31.6 ± 1.1 eggs/g of feces, which is on average 19.9 more specimens than in 1–2-month-old calves. In adult cattle older than two years, the rates of infection with the causative agent of strongyloidiasis are also much lower than in 3–4-month-old young animals. In them, the extent of invasion does not exceed 50%, and the intensity of invasion is insignificant and amounts to an average of 12.6 ± 0.8 eggs/g of feces.

Thus, invasiveness causative agent of strongyloidiasis, 3–4-month-old calves have the highest indicators compared to calves of other age groups and adult cattle. According to the results of coprological studies, it was es-

tablished that the infection of calves with the causative agent of strongyloidiasis in the agricultural private enterprise "Chumaky" lasted throughout the year, although it had certain fluctuations in different periods (Table 2.3). As can be seen from the table, the high extent of strongyloidiasis in calves was maintained at the highest level (100%) from the end of autumn to the beginning of spring. Starting from April, it decreased and reached its lowest level by the end of summer – in August (55.6%), which, although it was 44.4% lower than in winter, nevertheless testified to a stable and sufficiently high level of animal damage.

Table 2.3

Seasonal dynamics of strongyloidiasis in calves in the APE Chumaky of the Dnipro district, 2009, h ± SE

Month	Number of examined animals	among them affected	Invasion extent, %	Intensity of infestation, eggs/g of feces
January	10	10	100	33.8 ± 1.9
February	12	12	100	33.8 ± 2.0
March	12	12	100	22.4 ± 1.4
April	10	9	90	9.7 ± 1,2
May	8	7	87.5	11.6 ± 1.1
June	8	6	80	8.7 ± 0.8
July	8	5	62.5	6.4 ± 3.3
August	9	5	55,6	6.6 ± 0.5
September	10	7	70	10.6 ± 1.5
October	10	7	70	11.4 ± 0.9
November	8	8	100	17.3 ± 1.7
December	10	10	100	34.4 ± 1.7
In total	115	98	–	–
In average	–	–	84.6	17.2 ± 1.5

On average, the extent of infestation in calves aged 3–4 months of this farm was 84.6% over the course of a year. The intensity of the invasion had indicators that correlated with the level of damage to the calves by the causative agent of strongyloidiasis. Thus, in winter, the intensity of infestation averaged 34.0 eggs/g of feces, while in the summer months it was lower by 26.8 eggs/g of feces and amounted to an average of 7.2 specimens.

When summing up the average monthly indicators of the extensiveness of invasion, given in the table and figure 2.5, we note noticeable fluctuations in the level of infestation of young cattle by the causative agent of strongyloidiasis by season.

These indicators indicate an increase in infestation and the highest level of infection of 3–4-month-old calves by the causative agent of strongyloidiasis in winter – 100%, and, conversely, a decrease, albeit insignificant, in spring (average 92.5%), and especially summer months – 66 %. Such dynamics of strongyloidiasis confirms its name "stall invasion".

Animals in the private agricultural enterprise "Chumaky" are kept untethered in the premises almost all year round, although the side walls are open in the warm season. The same studies were conducted in farms where animals are kept according to the pasture -stall system: in the state enterprise "Research Farm of Dnipro" of the Institute of Grain Management of the Eastern Zone of the National Academy of Agrarian Sciences and in individual farms of citizens of the private sector in the villages of Partyzanske, Novooleksandrivka and Natalivka of the Dnipropetrovsk district.

According to the results of coprological studies, it was confirmed that in the body of calves under the age of 6 months, which belonged to the state enterprise "Research Farm Dnipro" S. papillosus parasitize throughout the year both in stable and pasture periods (Table 2.4).

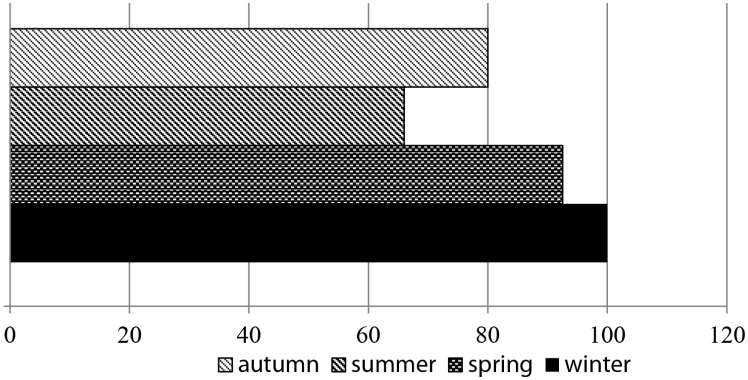


Fig. 2.5. Seasonal fluctuations of the level of strongyloidiasis in calves (extent of infestation, %) at the agricultural private enterprise "Chumaky", Dnipropetrovsk district, 2009

The extent of strongyloidiasis in the studied animals was higher by 42.2 and 20%, respectively, in the stable and pasture periods, compared

to cattle of private farms, but still by 27.6% lower in the warm period of the year and by 15% in the stable period than in the animals of the private agricultural enterprise "Chumaky", which can probably be explained by different methods and conditions of their keeping.

Table 2.4

Invasion of calves by the causative agent of strongyloidiasis in the style and pasture environment ± SE, n = 15

Households	Number of affected animals		Periods of keeping animals			
			stable		pasturable	
	Stable period	Pasture	Invasion extent , %	intensity, eggs/g feces	Invasion extent , %	intensity, eggs/g feces
Research Farm Dnipro	12	7	80,0	37,8 ± 2,1	46,7	18,9 ± 2,4
Village Partyzanske	7	4	46,7	9,9 ± 2,7	26,7	7,3 ± 1,3
Villlage Novooleksandrivka	4	3	26,7	9,3 ± 2,8	20,0	6,7 ± 1,1
Village Natalivka	6	5	40,0	10,8 ± 2,5	33,3	8,2 ± 1,4

Invasion of animals by the causative agent of strongyloidiasis varies depending on the way they are kept. Thus, in the state enterprise "Research Farm Dnipro" the level of strongyloidiasis was significantly higher (in 2.1 times), compared to the average indicators of infestation of animals of individual farms in the stable period of their maintenance and 1.7 times higher in the pasture period. Obviously, the fluctuations of indicators and weight gain of calves to a certain extent depend on different conditions of maintenance and the level of well-being of pastures. The incidence of strongyloidiasis in cattle during the dynamics and seasonal fluctuations mainly occurred during the stable period of the year. And, compared to these indicators in the month of pasture maintenance, the extensiveness and intensity of the invasion were almost twice as high.

The study of the peculiarities of the seasonal dynamics of infestations associated with strongyloidiasis showed that in the spring in the conditions of the steppe zone of Ukraine, the fate of each species in the group of ruminant nematode larvae was: Haemonchus sp. – 15.74%, Oesophagostomum sp. 22.75%, S. papillosus – 37.09%, B. phlebotomum – 24.42% (Fig. 2.6).

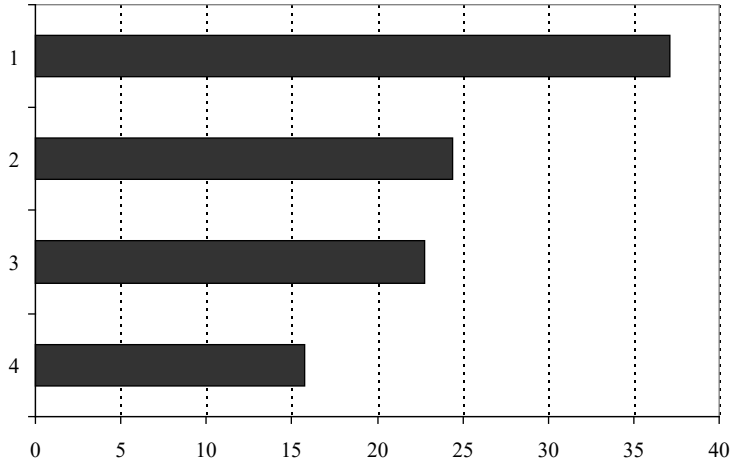


Fig. 2.6. The species composition of the groups of strongylid larvae and *S. papillosus* in the spring (share in the group, %) in the territory of Prydniprovya steppe: *1 – S. papillosus*, *2 – B. phlebotomum*, *3 – Oesophagostomum* sp., *4 – Haemonchus* sp.

Study of the diversity of Strongylida complexes and *S. papillosus* of livestock in July showed that in the summer the share of each species in the larval group of Strongylida and *S. papillosus* on of the territory of the steppe Prydniprovya was composed of: *Nematodirus* sp. – 2.34%, *D. viviparus* – 4.68%, *Ch. ovina* – 5.72%, *Haemonchus* sp. – 6.82%, *Oesophagostomum* sp. – 8.20%, *S. papillosus* – 14.83% and *B. phlebotomum* – 57.32% (Fig. 2.7). In the autumn period, the fate of each species in the group of Nematoda larvae in the conditions of the steppe zone was: *Nematodirus* sp. – 2.84%, *Haemonchus* sp. – 4.41%, *Ch. ovina* – 6.05%, *Oesophagostomum* sp. – 10.77%, *S. papillosus* – 30.34%, *B. phlebotomum* – 45.59% (Fig. 2.8).

In general, the level of strongyloidiasis in young cattle had similar fluctuations in the periods of the year, increasing in winter – spring and decreasing in hot months in farms with different methods of keeping them. All the same, there were more noticeable fluctuations in animals with summer camp maintenance on pastures, compared to those that were constantly in the premises.

Thus, the level of strongyloidiasis in animals depends on their age and period of the year. The rates of damage are significantly higher in young animals than in adult animals and are more significant in the stable period than in the pasture period.

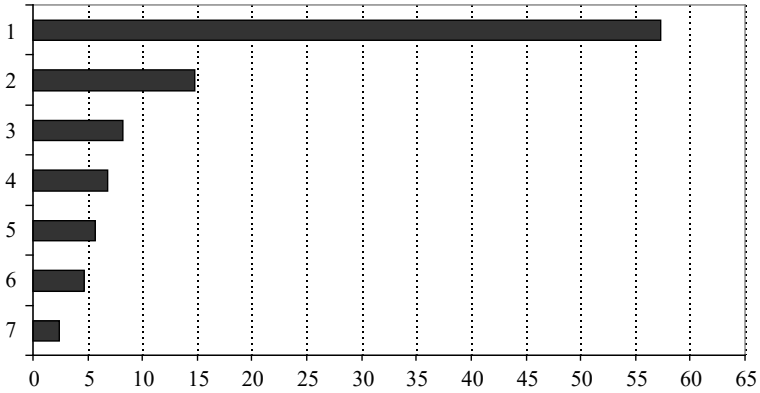


Fig. 2.7. The species composition of the groups of strongylid larvae and S. papillosus in the summer period (proportion in the group, %) in the territory of Prydniprovya steppe: 1 – B . phlebotomum, 2 – S. papillosus, 3 – Oesophagostomum sp., 4 – Haemonchus sp., 5 – Ch. ovina, 6 – D. viviparus, 7 – Nematodirus sp.

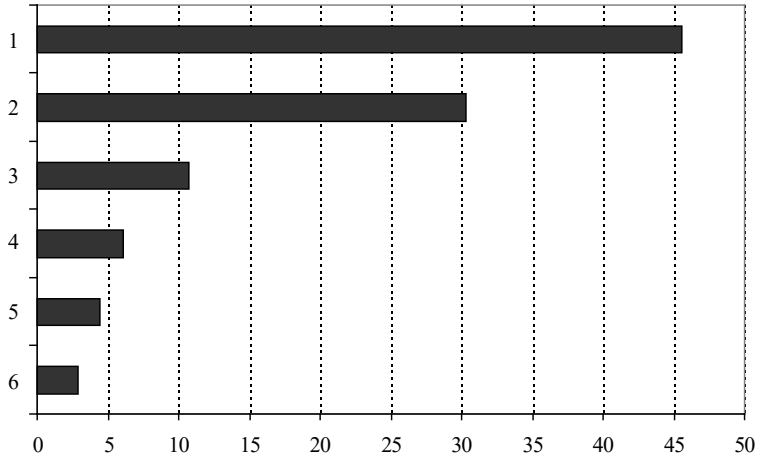


Fig. 2.8. The species composition of the groups of strongylid larvae and *S. papillosus* Wedl in autumn (share in the group, %) in the territory of Prydniprovya steppe: *1 – B. phlebotomum*, *2 – S. papillosus*, *3 – Oesophagostomum* sp., *4 – Ch. ovina*, *5 – Haemonchus* sp., *6 – Nematodirus* sp.

2.3. Infestation by the causative agent of strongyloidiasis of animals under different conditions of keeping

The results of studies of the epizootic situation in the farms of Dnipropetrovsk and bordering districts of Zaporizhzhya regions confirmed the significant spread of strongyloidiasis in calves. Most of the farms of this steppe territory, despite the sparseness of the land in the summer, keep livestock using pastures (summer-camp keeping) during the warm period of the year, which lasts from April to October. In some farms, cattle are not grazed, keeping them year-round in specially adapted, fairly open premises on deep, unchanging straw bedding. Out of 17 surveyed households in 9 districts of Dnipropetrovsk and three districts of Zaporizhzhia regions, 12 turned out to be unfavorable for this disease, which amounted to 70.6%.

Studies have shown that the spread of strongyloidiasis and the level of infestation by the pathogen in calves in the farms we surveyed in the Dnipropetrovsk and Zaporizhzhia regions are slightly different (Table 2.5).

Table 2.5

The level of infection of calves with the causative agent of strongyloidiasis in the farms of the Dnipropetrovsk and Zaporizhia regions in 2009–2011

Districts	Animals exemined		Invasion extent, %	Intensity of infestation, eggs/g of feces
	In total	Identified as seek		
1	*2*	*3*	*4*	*5*
Dnipropetrovsk region				
Dnipropetrovsk	136	91	66.9	34.1 ± 2.8
Novomoskovsk	41	7	17.1	21.9 ± 3.1
Synelnykove	27	8	29.6	26.2 ± 4.2
Verhniodniprovsk	36	11	30.6	27.1 ± 3.3
Sofiivka	114	59	51.8	32.3 ± 4.3
Yuriivka	20	13	65.0	36.2 ± 4.2
Pyatyhatky	34	14	41.2	34.2 ± 3.1
Kryvyi Rig	38	16	42.0	29.2 ± 2.2
Pavlograd	18	4	22.2	34.3 ± 2.7
In total	464	223	–	–

1	*2*	*3*	*4*	*5*
In average	–	–	45.9	30.6 ± 3.4
Zaporizhzhia region				
Vilne	24	11	45.8	21.4 ± 2.8
Zaporizhzhia	27	14	51.9	23.1 ± 3.3
Vasylivka	33	13	39.4 _	28.8 ± 2.2
In total	84	38	–	–
In average	–	–	45.7	24.4 ± 2.6
In total	548	2 61	–	–
In average	–	–	45.8	27.5 ± 3.5

In general the extent of infestation in different farms of both regions ranged from 17.1% to 66.9%, reaching 100% on some farms. The level of infestation of calves depends on the age, season, housing system and sanitary and hygienic conditions in the farm.

The level of infection of cattle by the causative agent of strongyloidiasis amounted to an average of 45.8%. At the same time, animals from Dnipropetrovsk, Yuryivka and Sofiivka districts had high rates of infestation: 66.9%, 65% and 51.8%, respectively.

Percentage of animals affected by the causative agent of strongyloidiasis in the farms of Pavlograd and Novomoskovsk districts was the lowest and did not exceed 22.2 and 17.1, respectively.

The maximum extent of infestation was observed in calves aged 3–4 months. The level of their damage was 76.1%, that is, out of 218 examined calves of this age, 166 were affected by the causative agent of strongyloidiasis. Intensity of infestation, on average, was 33.7 ± 4.1 eggs/g of feces, while in general in animals of different ages in farms of both regions it was 1.25 times lower.

The extensiveness of the infestation of cattle was the same. On the territory of Zaporizhzhia region, it was, on average, 45.7 %, which is only 0.2% lower than in the farms of Dnipropetrovsk region. Relatively high indicators of the extensiveness of this invasion were recorded in Zaporizhzhia district (51.9%), and the lowest were in Vasylivka district (39.4%). According to the intensity of the infestation, the animals of farms in the Dnipropetrovsk region were affected more by 6.2 eggs/g of feces.

The question of the spread of strongyloidiasis in young cattle in individual farms of citizens of the villages of Partyzanske, Novooleksandrivka

and Natalivka of the Dnipropetrovsk district was also clarified. A total of 132 animals of various ages were studied.

As the results of coprological studies showed, 37.2% examined animals farms in the villages of Dnipropetrovsk district had strongyloidiasis (Table 2.6).

Table 2.6

Infestation of young cattle with the causative agent of strongyloidiasis in individual farms of the Dnipropetrovsk district

Settlement	Number of examined animals	Among them affected	Invasion extent, %	Intensity of infestation, eggs/g of feces
Village Partyzanske	55	24	43.6	17.2 ± 3.4
Villlage Novooleksandrivka	46	12	26.1	31.1 ± 4.1
Village Natalivka	31	13	41.9	23.4 ± 2.8
In total	132	49	–	–
In average	–	–	37.2	23.9 ± 3.4

From the data of the table, we can see that extensity of infestations of calves in these farms fluctuated from 26.1 to 43.6%, which is 8.6% lower than average indicator in production enterprises. Intensity infestations on average was 23.9 ± 3.4 eggs/g of feces. At the same time, indicators of intensity of invasions fluctuated and were the highest in calves of Novooleksandrivka – 31.1 ± 4.1 eggs, which is 13.9 more compared to the indicators of village Partyzanske.

Such fluctuations in the intensity of infestation can probably be explained not only by different systems and conditions of keeping livestock, but also by the level of well-being of the pastures on which they graze.Studies have shown that the causative agent of strongyloidiasis in cattle in Dnipropetrovsk farms *is S. papillosus.* This was confirmed by the morphology of the eggs of *S. papillosus*, as well as by the body structure of rhabditid-like (first and second stages) and filarial-like larvae (Fig. 2.9).

Eggs *of S. papillosus* are quite easily differentiated from the eggs of other helminths, which are excreted by infested animals with feces. They are oval-shaped, with almost parallel side walls, gray, single-layer transparent shell, mature. In the middle of the egg there is a formed larva, the movement of which is easy to notice under a microscope.

Fig. 2.9. Eggs and larvae of *S. papillosus* in the feces of calves, bar = 50 μm

Rhabditid-like larvae of *S. papillosus* differ from the larvae of other nematodes that parasitize in the alimentary canal of cattle and are also cultivated under favorable conditions in feces by those with characteristic expansions on the esophagus. Rhabditid-like larvae of free-living first and second stages of *S. papillosus* differ from each other in the presence of one or two expansions (bulbs) on their esophagus, respectively, as in Figure 2.9, and the invasive filarial larva has a cylindrical esophagus. Therefore, strongyloidiasis of animals is widespread in the conditions of the steppe zone of Ukraine. Affected livestock due to different ways of keeping them is, on average, 41.5%. The level of strongyloidiasis damage in animals of production livestock farms is higher by 8.6% compared to individual farms.

2.4. The role of litter and soil in the preservation of invasive *Strongyloides papillousus* larvae in the environment

At the same time as determining the prevalence of strongyloidiasis in cattle in farms of the Dnipropetrovsk region, we established the role of litter and soil of pastures and territories of livestock farms in the preservation of invasive eggs and larvae.

In the literature, strongyloidiasis is often called "stable invasion", which implies the time of possible infection of animals – autumn-spring, that is, the period of their keeping. The probability of infection of cattle, especially young animals, during the grazing period can be predicted by the number of larvae of *S. papillosus* in different soil layers of pastures or walking yards

and paddocks. We investigated soil samples taken from the surface layer and a depth of 10–20 cm from the pastures of the Research Farm Dnipro, in Dnipropetrovsk district, agricultural firm "Krasnyi Zaboishchyk" in Kryvyi Rig district, farm "Zoria", in Yuryivka district and paddocks in the villages Natalivka, Partyzanske, and Novooleksandrivka. Both in the grazing and stable periods of keeping cattle, larvae of *S. papillosus* and gastrointestinal strongylatoses were found in the samples. (Table 2.7).

Table 2.7

Contamination of pasture soils with larvae of *S. papillosus* (x ± SE, n = 10)

Households	Grazing period		Steel period	
	surface layer of the soil, larvae/kg	soil depth 10–20 cm, larvae/kg	surface layer of the soil, larvae/kg	soil depth 10–20 cm, larvae/kg
Research Farm Dnipro	2213.7 ± 11.3	58.9 ± 2.3	27.1 ± 2.1	1118.0 ± 7.2
Agricultural firm "Krasnyi Zaboishchyk"	1892.5 ± 8.3	65.1 ± 2.9	21.8 ± 1.4	142 9.5 ± 11.2
Farm "Zoria"	2019.2 ± 11.4	47.5 ± 8.7	41.1 ± 5.2	1011.7 ± 19.3
Village Partyzanske	1474.1 ± 7.4	117.1 ± 4.9	21.3 ± 1.7	872.6 ± 4.8
Villlage Novooleksandrivka	9 87.9 ± 5.4	49.3 ± 1.6	18.9 ± 3.4	729.1 ± 3.3
Village Natalivka	1214 .8 ± 6.7	97.1 ± 2.7	53.8 ± 2.4	1093.5 ± 7.3

As can be seen from Table 2.8, soil colonization by invasive helminth larvae in cattle grazing areas was significant in different periods and depended on the system and method of keeping. Thus, the pastures of production farms with summer grazing animals were the most contaminated with larvae, and to a lesser extent, pastures where cattle of individual owners were grazed. In our opinion, this can be explained by the number of animals that graze on them, as well as the fact that pasture areas of farms often have lowlands. areas covered with ravines, overgrown with shrubs, which creates favorable conditions for invasive eggs or larvae and allows them to persist in the environment for a long time.

According to the periods of keeping animals (stall and pasture) and the study of samples from the soil surface and 10–20 cm deep, the contamina-

tion was also different. In particular, during the stable period, the number of larvae of S. papillosus in 1 kg of soil in the surface layers of pastures was less, than in pasture land: in Research Farm Dnipro – by 2154.8, in agricultural firm "Krasnyi Zaboishchyk" – by 1827.4 and in the farm "Zoria" – by 1971.7 specimens.In the soil samples of Partyzanske, Novooleksandrivka and Natalivka villages, their number is less by 1357, 938.6 and 1117.7 specimens, respectively. On the contrary, the soil samples from a depth of 10–20 cm contained more larvae during the stagnant period. Thus, there were, respectively, 1090.9, 1407.7, and 970.6 more specimens in 1 kg of soil in samples from the pastures of Research Farm Dnipro, agricultural firm "Krasnyi Zaboishchyk", in the farm "Zoria" and – by 851.3, 710.2, 1039.2 specimens more in soil samples from the territory of village walks, compared to the pasture period.

It was defined, that the pastures of production farms during the period of stable keeping of cattle, in contrast to the soils of pastures where the individual owners' animals graze, are contaminated with a more diverse helminth fauna. Gastrointestinal strongylatoses pathogens were differentiated among the helminth larvae found on the soil surface (*Chabertia* sp., *Haemonchus* sp., *Bunostomum* sp.) and nematodes of the order Strongylata of respiratory organs (*Dictyocaulus* sp.), while in soil samples of pastures of individual owners – only *Haemonchus* sp. and *Bunostomum* sp.

The contamination with larvae *of S. papillosus* in different periods of the year confirms the possibility of preserving the viability of their invasive larvae during the autumn-winter period. The data we obtained are confirmed by the previous results of O.O. Boyko's research, who considered meadows, pastures, and pastures where animals were for a certain time to be a dangerous area due to the possibility of their infection with pathogens of certain types of helminths in the next grazing period [20].

We also found out the contamination of the territory of the farms of production farms with larvae *of S. papillosus*. For this purpose, soil samples were taken at a distance of 10 cm and 2 m from livestock premises and walking yards in the Research Farm Dnipro, the private agricultural enterprise "Chumaky" of the Dnipropetrovsk region, the agricultural company "Krasnyi Zaboishchyk" in Kryvyi Rig district, the farm "Zoria" in Yuryivka district in different periods of the year. The larva *of S. papillosus* was not found in any farms' samples, which can probably be explained by the unfavorable conditions for their development in these areas open to the sun. At the same time, bedding of the calf premises, regardless of the time of re-

search, the number of larvae of *S. papillosus* and their activity were significant. Larvae were found in different periods of the year at different stages of development, which indicated that the process of heterogony does not stop. To carry out quantitative studies to find out the level of contamination of litter with invasive larvae of *S. papillosus* in livestock premises, we took samples at the Research Farm Dnipro, where animals are raised according to the stable-pasture system with summer-camp conditions of keeping, at the private agricultural enterprise "Chumaky" – where calves are constantly, throughout the year, in premises on deep litter, unattached as well as in individual farms.

To count the number of larvae in samples of bedding material of livestock premises, the same methodology was used as during soil research. Average indicators of litter material contamination by larvae *of S. papillosus* are listed in Table 2.8.

Table 2.8

Contamination of litter with larvae of *S. papillosus*, larvae/kg, x ± SE , n = 10

Households	Spring	Summer	Autumn	Winter
SE "DG Dnipro"	2195.1 ± 15.4	–	974.5 ± 13.2	1228.1 ± 7.3
SPP "Chumaki"	2234.4 ± 7.6	1092.4 ± 10.5	1418.9 ± 9.6	1277.1 ± 15.3
Individual farms	726.7 ± 7.2	44.2 ± 6.2	674.1 ± 12.7	915.2 ± 6.0

As can be seen from the data given in the table, infestation by larvae *of S. papillosus* bedding of the premises on which the calves are kept is constant, although it varies depending on the way they are kept and the season. Thus, in the litter, selected from the premises of individual farms, the larvae *of S. papillosus* was found significantly less than under conditions a summer-camp system for keeping calves (as in the research Farm Dnipro), or for a permanent indoor keeping system (as in the "Chumaky" agricultural private enterprise). These indicators averaged less than 1468.4 and 1507.3 in spring, 1048.2 in summer, 300.4 and 744.8 in autumn, and 312.9 and 361.9 in winter larvae/kg litter correspondingly.

Throughout the year, litter contamination rates were highest in production farms (with different management systems) in spring, while in individual farms – in winter. On the contrary, the lowest rates of infestation of bedding material were in the summer when the animals were kept indoors permanently, and in the fall when the animals were moved indoors

during the summer camp keeping of the animals. Thus, the conducted studies confirmed that the soil and litter in livestock premises are a kind of reservoir of invasive larvae of *S. papillosus*. Larvae remain viable in the soil of pastures during the stall period, which maintains their contamination and is a factor in the probable infection of animals during grazing in the next pasture period. At the same time, *Strongyloides* sp. larvae was not found in soil samples taken near livestock buildings.

Chapter 3. MORPHOFUNCTIONAL CHANGES IN THE ORGANS OF MAMMALS (CATLE) WITH STRONGYLOIDOSIS

3.1. The dynamics of changes in some clinical indicators of the body of cattle with strongyloidiasis

Pathogenetic influence of parasites on the body of the host is necessarily accompanied by certain morphofunctional manifestations in its condition and behavior. Depending on the intensity of the invasion, the characteristic manifestations and reaction of tissues and organs of different systems may be different. Clinical signs of invasive diseases caused by helminths, as a rule, are not pathognomonic, but they must be taken into account during diagnostic studies. Individual changes in indicators of the general state of the animal's body allow to predict helminthiasis, and the results of hematological studies – to confirm them [147, 148]. We took into account the results of the examination of the general condition of the animals – body temperature, pulse and breathing rates and reduction of the scar, as well as morphological and biochemical indicators of blood. During the clinical examination of the calves, their low activity, lethargy, depression, deterioration of appetite, and often anemia of visible mucous membranes was noted.

The body temperature was elevated to 39.1 °C. The frequency of pulse and respiratory movements in calves had significant changes, compared to such indicators in animals of the control group, free from strongyloidiasis (Fig. 3.1). As can be seen from the figure, in calves affected by the causative agent of strongyloidiasis, the pulse was accelerated by 13.9%, and the respiratory rate exceeded this indicator in control animals by 40.4%, or by 1.68 times at $p<0.001$, while the number on the contrary, scar rolling was 47% less than in the control and amounted to 3.5 ± 0.12 reductions in 5 minutes ($p<0.001$).

In addition, specific manifestations of damage to the nervous system (short excitement and prolonged depression, increased skin sensitivity) and gastrointestinal tract (liquid feces with an unpleasant odor) were observed in the infested calves.

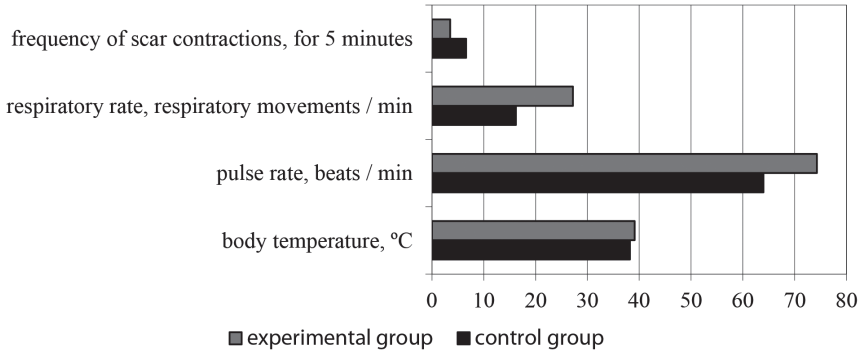


Fig. 3.1. General clinical indicators in calves for strongyloidiasis , n = 10

Thus, strongyloidiasis in young cattle is manifested by general depression, disorders of the digestive tract, changes in the general clinical condition, which were characterized by an increase in the frequency of breathing, pulse, body temperature and a decrease in the frequency of contractions of the rumen.

3.2. Morphological parameters of the blood of calves for strongyloidiasis

The course of strongyloidiasis in calves was accompanied by changes in blood parameters. Thus, we noted a significant decrease in the hemoglobin content by an average of 18 g/l ($p<0.05$) and a decrease in the number of erythrocytes by an average of 2.1 T/l ($p<0.01$) in calves of the experimental group spontaneously affected by the pathogen strongyloidiasis, compared to the same indicators in the control (Table 3.1). Due to the toxic effect of helminths on the animal body, suppression of erythrocytopoiesis in the red bone marrow is observed against the background of chronic intoxication, as a result of which anemia develops.

At the same time, the number of leukocytes in the blood of experimental animals was higher on average by 4.6 g/l ($p<0.001$), compared to the control, which indicates an inflammatory process in their body. In the leukogram of the blood of the experimental animals, persistent eosinophilia was noted . The number of eosinophils in the leukogram was 3.5 times higher compared to the indicators of the control group and amounted to 18.72 ± 0.62 %. As is known [116, 122, 153, 199], an increased number of these cells in the blood of animals is always an indicator of an organism's

allergy, and significant eosinophilia , as a rule, indicates the existence of parasites in the body.

Table 3.1

Morphological indicators of the blood of calves for strongyloidiasis, x ± SE; n = 10, p<0.05

Indicators	Groups of animals	
	control	research
Hemoglobin, g/l	131.1 ± 1.4	113.2 ± 2.1**
Erythrocytes, T/l	6.72 ± 0.14	4.62 ± 0.31*
Leukocytes, g/l	7.21 ± 0.29	11.81 ± 0.92*
Leukogram , %		
Basophils	0.1 2 ± 0.03	0.9 4 ± 0.05
Eosinophils	5.3 1 ± 0.42	18.7 2 ± 0.62 **
Neutrophils :		
rod nuclear	2.4 4 ± 0.01	3.0 2 ± 0.03
segment nuclear	30.4 ± 1.31	22.5 ± 11.53
Lymphocytes	58.62 ± 1.51	48.1 2 ± 2.32
Monocytes	3.21 ± 0.33	6.80 ± 0.73

*Notes. *p<0.01 – compared to the control group of animals; **p<0.001 – compared to the control group of animals.*

The number of lymphocytes in the blood of animals of the experimental group was significantly different from the indicators in the control. It was 10.5% (p<0.05) less than in animals of the control group. Lymphocytes, as is known [102], take an active part in the implementation of immunological reactions, perform an antitoxic function, adsorbing and inactivating toxins of various origins, in lipid metabolism, produce humoral factors that stimulate tissue regeneration. Taking this into account, the changes in the leukogram noted by us indicate suppression of the resistance of the animal body to various antigenic stimuli against the background of strongyloidiasis.

Similar to the number of lymphocytes, infected with *S. papillosus* calves, the share of segmented nuclei also decreased neutrophilic leukocytes (by 7.9%, p<0.05). Given that neutrophils are the main phagocytic blood cells, it can be assumed that the cellular link of immunity is also

suppressed during the development of the disease. Probably, the changes noted by us characterize the toxic effect on the myeloid tissue of the red bone marrow. In addition, part of the functions of neutrophil leukocytes can be performed by eosinophils, which are also capable of phagocytosis.

It should be noted that an increase in the number of monocytes was noted during the development of the disease in calves. Considering that these blood cells have a pronounced macrophage reaction and participate in immune defense reactions, in particular, the transfer of information about the structures of an antigenic stimulus to immune memory cells, we tend to consider the development of monocytosis as a compensatory reaction to neutropenia and lymphopenia.

We suppose that the peculiarities of the morphological composition of the blood of calves with strongyloidosis that we have established are caused by mechanical damage to body tissues by migrating larval stages, which became a factor in inflammatory phenomena in various parts of the body and internal organs. This is related to the ways of possible penetration of the larvae (percutaneous or alimentary), as well as to the parasitism of sexually mature hermaphrodite females in the intestines. In addition to the mechanical effect of helminths, the probable cause of inflammatory phenomena and the possibility of an inoculating effect of larvae should not be ruled out. At the same time, the main link of pathogenesis, most likely, is toxic, which leads to the suppression of erythropoiesis and, to a certain extent, the organs of immune protection. Our data coincide with the results of O. V. Dyomkina research [46].

Thus, the results of morphological studies of blood indicate significant changes in the internal environment of the body of sick calves and testify to suppression of its main vital functions.

3.3. Biochemical indicators of the blood of calves for strongyloidiasis

The pathogenic effect of helminths on the body of sick calves was also reflected in the indicators of the biochemical composition of the blood, as can be seen from the data in Table 3.2. In calves with strongyloidiasis, changes in the biochemical parameters of the blood were accompanied by a significant ($p<0.05$) increase in the content of total protein in its serum to the upper limit of the norm (87.22 ± 2.72 g/l). At the same time, dysproteinemia was characterized by a sharp decrease in the level of albumins on average by 7.4 g/l with $p<0.01$ and an increase of 14 g/l of globulin

fractions (p<0.01), compared to the indicators in animals of the control group. This ratio of serum protein fractions in the calves of the experimental group caused a probable decrease in the albumin-globulin ratio to 0.46 ± 0.04 (p<0.01), which is 1.65 times lower compared to the indicator in the control. These changes are characterized by a decrease in the synthesis of albumins in the liver, which, in our opinion, is a consequence of a violation of the process of assimilation of feed amino acids as a result of a violation of the structure of enterocytes. At the same time, the presence of an antigenic stimulus in the body led to increased production of immunoglobulins in the organs of immune protection, which led to the development of hyperglobulinemia and hyperproteinemia.

Table 3.2

Biochemical parameters of the blood of calves for strongyloidiasis, x ± SE, n = 10

Indicators	Groups of animals	
	control	research
Total protein, g/l	80.62 ± 2.66	87.22 ± 2.72 *
Albumins, g/l	34.81 ± 1.54	27.4 ± 1.44**
Globulins, g/l	45.81 ± 2.42	59.83 ± 3.77**
Albumins/globulins	0.762 ± 0.073	0.46 ± 0.04***
Glucose, mmol/l	4.04 ± 0.06	3.02 ± 0.04**
ASAT, units/l	65.31 ± 0.61	68.2 ± 2,32
AlAT, unit/l	60.2 ± 0.53	64.73 ± 1,21

*Notes: *p<0.05, **p<0.01, ***p<0.001 compared to the control group of animals.*

A significant decrease in the concentration of glucose in the blood of the calves of the experimental group by an average of 1.02 mmol/l (p <0.05) compared to this indicator in the control indicates a decrease in the body's energy supply. This can probably be explained by the reduced absorption of glucose from feed in the intestines, as well as the increased use of this monosaccharide to meet the energy needs associated with the repair of damaged tissues.

At the same time, the activity of peramination enzymes did not change significantly in the blood serum of animals. It is known from literary sources that AsAT and AlAT are contained in the cells of the liver, lungs, kidneys,

myocardium, and skeletal muscles, as well as in the pancreas and erythrocytes [187]. Since they instantly react to the development of pathological processes in the body, intensively entering the blood from the cells of the myocardium and liver, where they are in significant concentrations, the absence of changes in their catalytic activity indicates a slight pathogenic effect on cardiomyocytes and hepatocytes. Considering the detoxifying functions of the latter, it can be assumed that the liver of animals has sufficient functional reserves to ensure the inactivation of Strongyloides toxins.

Thus, strongyloidiasis of calves with their spontaneous damage occurs with noticeable disturbances of metabolic processes in the body and is accompanied by changes in the protein composition of the blood. This indicates the pathogenic effect of pathogens on the animal body. Anemia, eosinophilia, monocytosis, dysproteinemia (hypoalbuminemia and hyperglobulinemia) and hypoglycemia were observed in sick animals during hematological studies.

3.4. Morphostructural changes in individual organs of calves due to strongyloidiasis

Our research on the morphological characteristics of tissues of organs spontaneously invaded by the causative agent of strongyloidiasis of calves confirmed the development of significant macro- and microstructural changes in their body. The corpses of animals affected by the causative agent of strongyloidiasis are emaciated, the figure is proportional, the skin is thin, not elastic. During the pathological-anatomical autopsy of the dead calf, it was noted: the wool cover is dull, disheveled, poorly fixed in the skin, in some places pronounced areas of alopecia. Visible mucous membranes are pale, dry, with a grayish tint. A small amount of straw-colored fluid was found in the abdominal cavity, which is a sign of general intoxication of the body. The serous coating of the intestine is dull. During the transdermal route of entry of parasites into the body of calves, the pathological and anatomical changes of the skin, especially the lower part of the abdomen and the inner part of the thighs, were quite pronounced. They were characterized by the development of dermatitis, which took over the subcutaneous tissue in the form of edema, spot hemorrhages, eosinophilic and lymphoidocytic reactions.

Surface lymphatic nodes of characteristic shape and normal volume, white-gray from the surface and in section, not elastic enough, dry. The thyroid gland has a lobular structure, is brownish -red in color, and is suffi-

ciently elastic. Visible mucous membranes and mucous membranes of the upper respiratory tract, as well as the anterior part of the digestive tube, are reddish-gray in color with well-filled blood vessels. Dotted hemorrhages on the mucous membranes of the larynx and trachea. The trachea contained a whitish foamy liquid with impurities of mucus (Fig. 3.2).

During the penetration of invasive larvae and their migration in the body of calves, quite intense pathological and anatomical changes in the lungs were noted. Larvae significantly injure blood vessels and lung parenchyma, causing small massive hemorrhages.

The lungs are red, half-burnt, in some places with small blisters protruding above the surface of the lungs, which crepitate when pressed. The cranial lobes of the lungs are dark red in color and have a dense consistency.

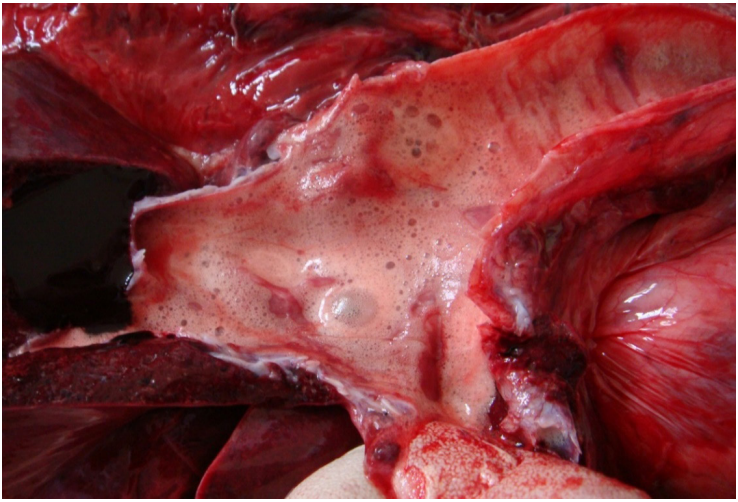


Fig. 3.2. The presence of foamy liquid in the trachea 3-month-old calf for strongyloidiasis

Pieces of the affected areas of the lungs are bright red, sink in water, have a vitreous appearance, and are significantly filled with blood.

Histological examination of the lungs revealed areas of atelectasis (Fig. 3.3).

In foci of atelectasis, the alveoli collapse and their contours are barely visible. The vessels are full of blood. Changes in lung tissue indicated thinning or destruction of interalveolar partitions; in some areas, on the contrary, they are thickened due to infiltration by monocytes, lymphocytes, and erythrocytes.

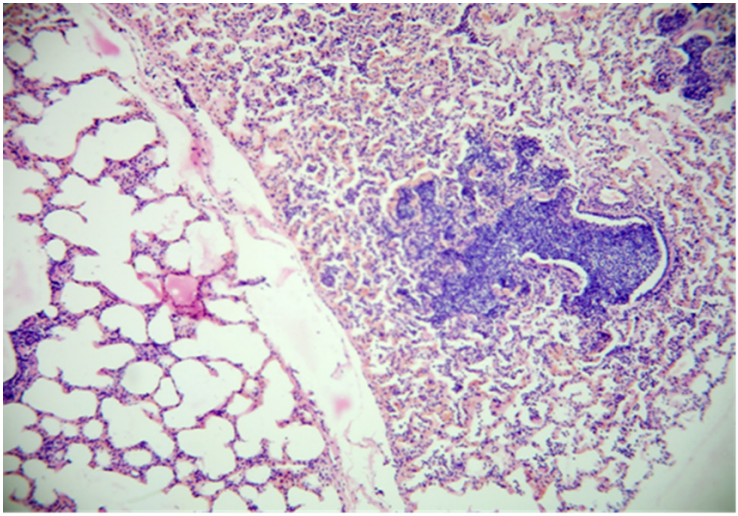


Fig. 3.3. Area of atelectasis due to strongyloidiasis (Hematoxylin and eosin, × 100)

Along with this, areas of compensatory emphysema were noted (Fig. 3.4).

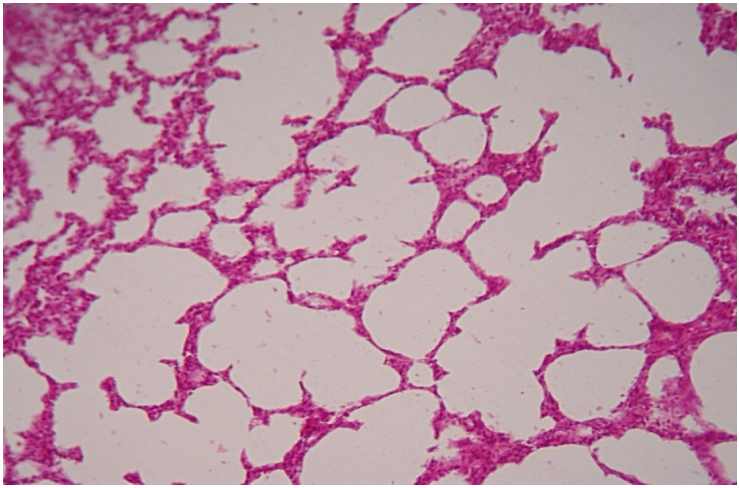


Fig. 3.4. Area of compensatory emphysema due to strongyloidiasis (Hematoxylin and eosin, × 200)

At the same time, the alveoli are stretched, their partitions are thinned. During the long course of strongyloidiasis, catarrhal broncho-

pneumonia was noted in the lung tissue. In areas of bronchopneumonia, interalveolar septa are thickened due to infiltration with a large number of lymphocytes, a smaller number of neutrophils, as well as monocytes and eosinophils. Alveoli have the appearance of small cavities of various sizes and shapes. In some areas, the interalveolar partitions are completely destroyed.

At the same time, mucus and lymphocytes were found in the lumen of the bronchi. In the alveoli, desquamated cells of the respiratory epithelium, histiocytic-lymphoid infiltration (Fig. 3.5). The heart muscle is flaccid, grayish in color. The cut surface is wet, the blood vessels of the heart are filled with blood. A large amount of blood in the right half of the heart. The blood does not clot, it is dark. The ratio of the wall of the left ventricle to the wall of the right ventricle is 4.5:1, which indicates myocardial dystrophy with dilatation of the right ventricle. Dotted hemorrhages under the epicardium and endocardium were also noted (Fig. 3.6). A small amount of straw-colored fluid was found in the abdominal cavity, which is a sign of general intoxication of the body. The location of the organs is anatomically correct, the peritoneum covering the wall of the intestinal tube is hyperemic. There are no fat deposits in the subcutaneous tissue and in the thickness of the omentum and around the kidneys.

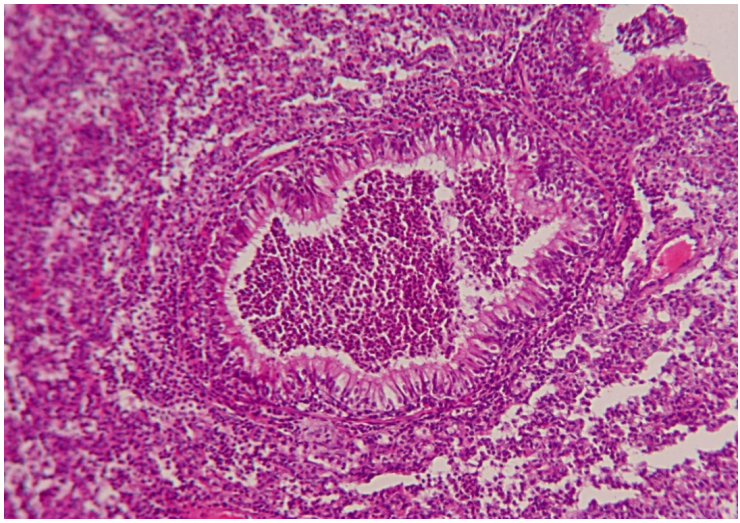


Fig. 3.5. Foci of catarrhal pneumonia due to strongyloidiasis (Hematoxylin and eosin, × 100)

Spleen with wrinkled edges and a wrinkled capsule, grayish on the surface, on the section with a mesh pattern, without parenchyma granularity characteristic of the spleen, the surface of the section is dry, scraping is not significant, the blood supply of the vessels is weak.

The liver is of the correct shape and volume, has a smooth capsule, slightly increased in size and compacted. Its capsule is tense, thickened, the color of the organ is uniform dark red, elasticity is increased. The bile ducts and bile ducts contain a small amount of bile. Gallbladder is weakly filled. Bile is dark green. The patency of the main drainage channels is preserved.

Fig. 3.6. Hemorrhages on the endocardium due to strongyloidiasis. Macro preparation

The kidneys are of a slightly compacted consistency, covered with a thin connective tissue capsule that is easily removed. They are enlarged, bulging on autopsy, dark red in color, the boundary between cortical and medullary substances is not clearly delineated. In the area of the fat capsule – serous atrophy of fat. Yellowish jelly -like masses indicate exhaustion of the animal. Changes in the urinary channels have not been established. The serous membrane of the small intestine, especially the duodenum, is intensive hyperemic. The vessels of the small intestine and mesentery are significantly filled with blood, which is clearly visible, up to small branches (Fig. 3.7).

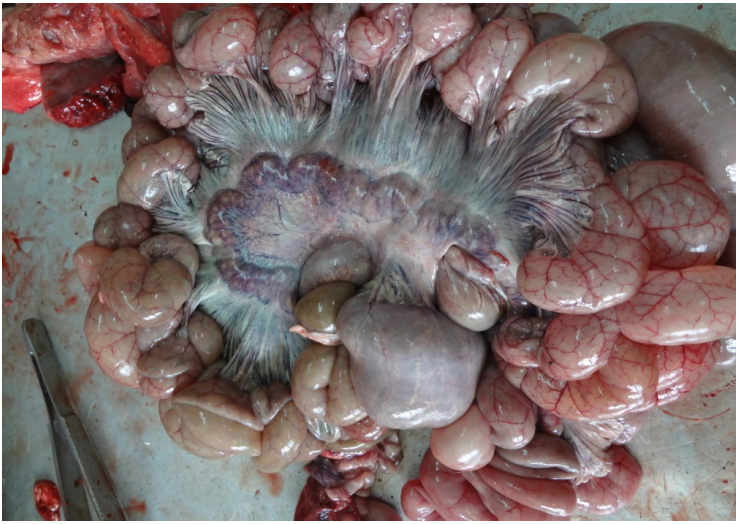


Fig. 3.7. The empty intestine of a 3-month-old calf due to strongyloidiasis

The mucous membrane of the duodenum and jejunum is swollen, moist, hyperemic, thickened, gray-red in color, with hemorrhages and covered with thick cloudy, viscous mucus (Fig. 3.8).

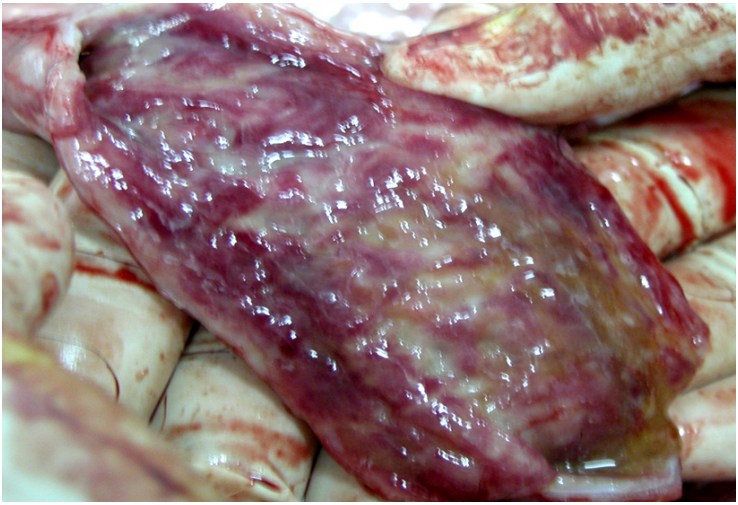


Fig. 3.8. Catarrhal and hemorrhagic inflammation of the jejunum

During histological examination of the duodenum, the destruction of villi with the formation of necrotic detritus on the surface of the mucous membrane was noted (Fig. 3.9). The vessels of the lamina propria of the mucous membrane are dilated and filled with erythrocytes, which indicates stagnant hyperemia. In some places, the epithelium is completely destroyed. The presence of eosinophils in the lamina propria of the mucous membrane indicated the allergic effect of mature *S. papillpus* and migrating larvae. The submucosal base is in a state of edema. Diffuse lymphoid – histiocytic infiltration of the intestine was noted walls.

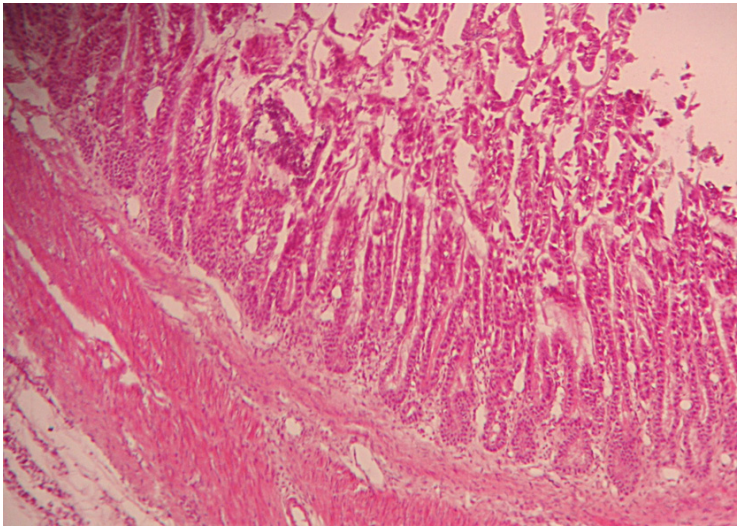


Fig. 3.9. Destruction and necrosis of the villi of the duodenum (Hematoxylin and eosin, × 100)

In the regional lymph nodes under the serous membrane of the small intestine, a capillary network with expanded blood vessels was clearly defined. Mesenteric lymph nodes were enlarged, dense, grayish-pink in color. The cut surface is convex, gray-pink in color, sometimes with dotted hemorrhages, moist, shiny (Fig. 3.10). On histological sections of lymph nodes, phenomena of lymphocytic infiltration against the background of rarefaction of the general cellular composition are visible (Fig. 3.11).

Thus, changes in the small intestine and regional mesenteric lymph nodes can be explained as a mechanical, toxic and inoculating effect of mature parasites and migratory stages of larvae when they enter the animal's body with food.

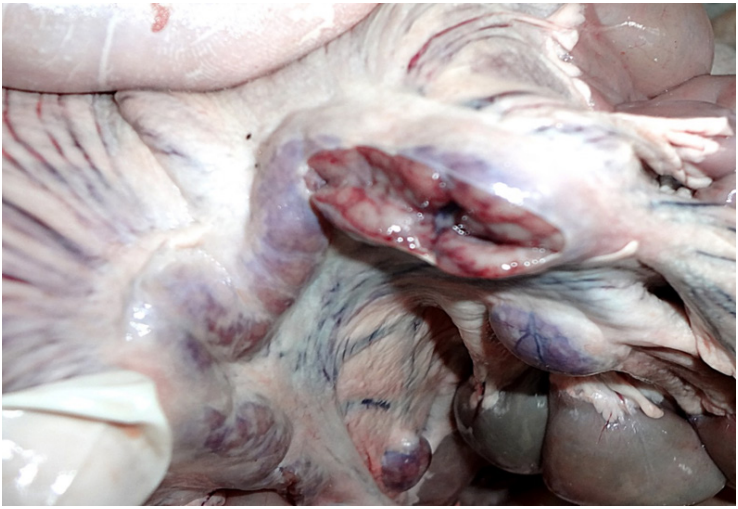


Fig. 3.10. Mesenteric lymph nodes of a 3-month-old calf at strongyloidiasis

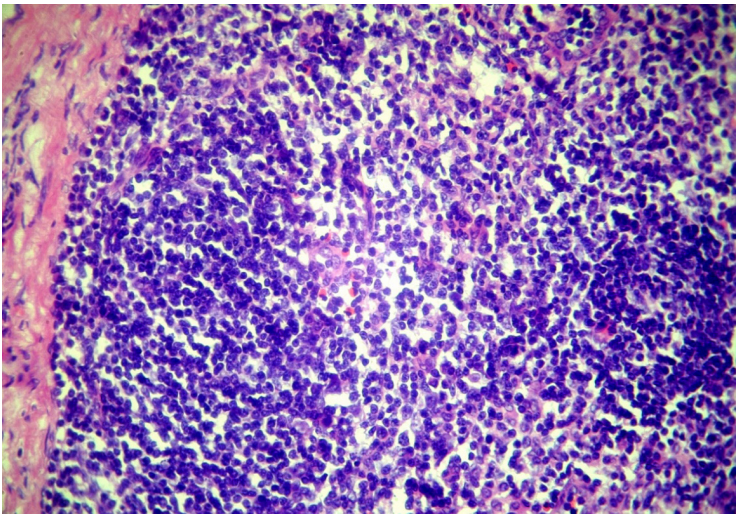


Fig. 3.11. Cellular devastation in a lymphoid nodule (Hematoxylin and eosin, × 100)

Parasitism of helminths in the body of calves causes significant pathological processes. The development of inflammatory processes is evidenced by structural changes in the examined organs. During histological

studies of intestines and regional lymph nodes of calves with strongyloidiasis, pronounced changes in the architecture of the tissues of these organs were observed. Hemorrhages, micronecrosis, lymphoid-histiocytic and eosinophilic infiltration are expressed in parenchymal organs during the migration of parasite larvae. Swelling and hyperplasia of lymph nodes are noted. In the lungs, catarrhal bronchopneumonia, areas of atelectasis and compensatory emphysema. Dystrophic, atrophic and inflammatory phenomena develop in the small intestine, which lead to a sharp thinning of the intestinal wall. Exacerbation of the pathological process manifests itself in the form of catarrhal and hemorrhagic enteritis.

Chapter 4. ASSESSMENT OF MUTAGENICITY OF *STRONGYLOIDES PAPILLOSUS*

4.1. Evaluation of the mutagenic effect of *Strongyloides papillosus* in the Ames test

The secretory-excretory products of life activity of helminths are unnatural substances for the body of the host and affect its physiological processes. One of the most important aspects of the interaction of "parasite-host" organisms is considered to be the mutagenic effect of the parasite on the hereditary apparatus of somatic and generative cells of the host [84]. To find out the level of such influence, there are cytogenetic methods, using which it is possible to register changes at the chromosomal and genomic levels of the organization of hereditary information in mammals One of the cytogenetic methods of rapid genetic risk assessment is the micronucleus test [151, 152]. This method is widely used in humane and veterinary medicine.

We studied the mutagenic effect of the excretory-secretory products of the larvae *of S. papillosus* at the gene level for both the type of base pair substitution and the type of frameshift in the *S salmonella typhimurium* test. At the same time, the mutagenic activity of the total homogenate from the larvae of *S. papillosus* was determined, the mutagenic activity of the lifelong secretions of these larvae and the mutagenic activity of the homogenate of the larvae in the Ames test.

Determining the mutagenic activity of the total homogenate of *S. papillosus* in the Ames test, we detected induction at the native and 10 times lower concentration on TA-98 and TA-100 strains. Excess of *Salmonella typhimurium* colonies over the control was within 2.3–4 times. In the experiments, the induction did not exceed 10 times, which according to the generally accepted scale of mutagenicity is estimated at 1 point (Table 4.1).

During the determination of mutagenicity of lifelong secretions of metabolic products of larvae *of S. papillosus*, induction was manifested in TA-98 and TA-100 strains (Table 4.2). In the study of three concentrations, it had an excess of 2.7 to 6.2 times the colonies in the experiment over the control in the strains.

Table 4.1

Mutagenic activity of the total homogenate of *S. papillosus* in the Ames test

Sample	Test stamp	Positive control	Dilution	Colonies of revertant			$\overline{X}$	$\frac{X_d}{X_k}$	Mutagenicity, score
				X_1	X_2	X_3			
A general homogenate of Strogyloides	TA-98	Daunomycin	6 μg / cup	318	348	296	320.7 ± 15.1	11.7	2
			spontaneous level of revertant	22	28	32	27.3 ± 2.9	–	–
			1	64	59	62	61.7 ± 1.5	2,3	1
			0,1	68	49	51	56.0 ± 6.0	2.1	1
			0.01	45	39	53	45.7 ± 4.1	1.7	0
	TA-100	Azide Na	1.5 μg / cup	598	612	608	606.0 ± 4.2	9.0	1
			spontaneous level of revertant	62	76	64	67.3 ± 4.4	–	–
			1	306	268	240	271.3 ± 19.1	4.0	1
			0,1	262	205	245	237.3 ± 16.9	3.5	1
			0.01	195	184	172	183.7 ± 6.6	2.7	0

Table 4.2

Mutagenic activity of lifelong secretions of larvae of *S. papillosus* in the Ames test

Sample	Test stamp	Positive control	Dilution	Colonies of revertant			$\overline{X}$	$\frac{X_d}{X_k}$	Mutagenicity, score
				X_1	X_2	X_3			
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Life-long secretions of larvae of Strogyloides	TA-98	Daunomycin	6 μg / cup	282	309	293	294.7 ± 7.8	15.3	2
			spontaneous level of revertant	18	22	18	19.3 ± 1.3		
			1	57	65	71	64.3 ± 4.1	3.3	1
			0,1	88	64	68	73.3 ± 7.4	3.8	1
			0.01	59	48	49	52.0 ± 3.5	2.7	1

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Life-long secretions of larvae of Strogyloides	TA-100	Azide Na	1.5 μg / cup	572	634	588	598.0 ± 18.6	9.1	1
			spontaneous level of revertant	68	63	67	66.0 ± 1.5		
			1	415	398	408	407.0 ± 4.9	6.2	1
			0,1	282	302	296	293.3 ± 5.9	4.4	1
			0.01	196	206	184	195.3 ± 6.4	2.9	1

It is important that the induction of gene mutations was detected in both strains at the native concentration, when diluted 10 and 100 times. Determination of mutagenic activity of larval homogenate S. papillosus, it was established that the induction of gene mutations occurs mainly by the mechanism of substitution of base pairs.

Table 4.3

Mutagenic activity of the homogenate of larvae of *S. papillosus* in the Ames test

Sample	**Test stamp**	**Positive control**	**Dilution**	**Colonies of revertant**			$\overline{X}$	$\frac{X_d}{\overline{X}_k}$	**Mutagen-icity, score**
				X_1	X_2	X_3			
Homogenate of Strongyloides larvae	TA-98	Daunomycin	6 μg / cup	321	312	375	336.0 ± 19.7	16.0	2
			spontaneous level of revertant	17	24	22	21.0 ± 2.1		
			1	51	54	63	56.0 ± 3.6	2.7	1
			0,1	37	42	49	42.7 ± 3.5	2.0	0
			0.01	32	28	31	30.3 ± 1.2	1.5	0
	TA-100	Azide Na	1.5 μ g g/cup	392	418	464	424.7 ± 21.1	6.9	1
			spontaneous level of revertant	52	63	69	61.3 ± 4.9		
			1	387	414	422	407.7 ± 10.6	6,7	1
			0,1	318	343	366	342.3 ± 13.9	5,6	1
			0.01	251	229	191	223.7 ± 17.5	3.6	1

In the analysis of the results of these studies, it should be noted that the excess of the number of colonies in the experiments compared to the control ranged from 2.7 to 6.7 times and (Table 4.3).

The mutagenicity of the larval homogenate was recorded on strain TA – 100 in all tested concentrations, and on strain TA – 98 only at the native concentration.

Therefore, the study of the mutagenic activity of the general homogenate of Strongyloides, the homogenate of larvae and their lifelong secretions revealed the probable induction of gene mutations, which was more related to the shift of the reading frame than to the replacement of base pairs.

4. 2. Indicators of the micronucleus test in erythrocytes of the peripheral blood of white rats

The analysis of preparations from different series of experiments showed that in the erythrocytes of the peripheral blood of white rats, micronuclei were detected with different frequency on different days of the experiment.

Yes, the study of the peripheral blood of white rats of the control group, according to the development of strongyloidiasis, showed that the number of erythrocytes with micronuclei varied from 1.0 ± 0.48 to 1.3 ± 0.33 in 1000 erythrocytes during the 42 days of the study. When rats of the research group were infected with invasive larvae *of S. papillosus* in the amount of 5 copies/g of body weight, already on the 7th day of the study, the frequency of detection of erythrocytes with micronuclei differed slightly from the same indicator in rats of the control group and was 1.2 ± 0.45 per 1000 erythrocytes. On the 14th day, the number of erythrocytes with micronuclei increased: 2.2 ± 0.52 ‰. By the 21st day, the number of micronuclei in erythrocytes probably exceeded this indicator by 2.6 times in animals of the control group ($p<0.05$). By the 42nd day of the experiment, the number of erythrocytes with micronuclei was 2.6 ± 0.74 ‰, which probably did not differ from such indicators in rats of the control group (Table 4.4).

When infection of laboratory animals increased (10 infested larvae per 1 g of body weight) up to the 7th day of infestation, the frequency of detection of erythrocytes with micronuclei was 2.3 times higher than such indicators in the control group ($p<0.05$). By the 14th day, the number of erythrocytes with micronuclei in infected animals was 2.8 times higher than in the control ($p<0.01$). The number of erythrocytes with micronuclei was on average 3.70 ± 0.64 ‰. On the 21st day of invasion, the number of erythrocytes with micronuclei was 4.5 times higher compared to the indicators in the control ($p<0.01$). By the 42nd day, the number of erythrocytes

with micronuclei in infected animals slightly decreased and amounted to 4.7 ± 0.82 per 1000 erythrocytes (p<0.01).

Table 4.4

The number of erythrocytes with micronuclei in the peripheral blood of white rats, ‰ x ± SE; n = 6

A day of research	Groups of animals			
	control	And experimental (5 larvae/g)	experimental (10 larvae/g)	III experimental (20 larvae/g)
7	1.10 ± 0.37	1.20 ± 0.45	2.50 ± 0.46*	3.60 ± 0.74*
14	1.30 ± 0.33	2.20 ± 0.52	3.70 ± 0.64**	5.90 ± 0.38***
21	1.20 ± 0.71	3.10 ± 0.28*	5.40 ± 0.62**	7.70 ± 0.92***
42	1.00 ± 0.48	2.60 ± 0.74	4.70 ± 0.82**	5.00 ± 0.91**

*Note and _ * p <0.05 – compared to the control group; ** p <0.01– compared to the control group; ***p<0.001 – compared to the control group.*

An increase in the number of invasive larvae during the infection of rats to 20 specimens/g of body weight had even more noticeable changes. Thus, on the 7th day of the development of strongyloidosis , the number of erythrocytes with micronuclei exceeded the control by 3.3 times (p<0.05). By the 14th day, the number of erythrocytes with micronuclei in the experimental animals was 4.5 times higher than in the control (p<0.001). On the 21st day after infection, the number of erythrocytes with micronuclei in the experimental rats was 6.4 times higher than in the control (p<0.001).

By the 42nd day of the experiment, the number of erythrocytes with micronuclei in the erythrocytes of white rats decreased slightly, which was also noted in two previous experiments, and amounted to 5.0 ± 0.91 ‰ (p<0.01).

Thus, micronuclei in the peripheral blood of rats were detected with different frequency depending on the number of invasive larvae *of S. papillosus* , with which they were infected during the days of research. The highest frequency of them was detected with the largest number of infections (20 larvae/g of body weight of rats).

Chapter 5. DIAGNOSIS, TREATMENT AND PREVENTION FOR STRONGYLOIDOSIS OF ANIMALS

5.1. Life-term diagnosis of strongyloidiasis

The diagnosis of strongyloidiasis, like any other helminthiasis, is confirmed comprehensively, taking into account epizootological data, clinical signs, laboratory test results and postmortem changes [37, 44, 45, 52, 56, 83, 85, 93, 136, 150, 162, 175, 187, 188].

T.V. Novikova notes changes in the extent of strongyloidiasis infestation at different times of the year, in animals of different ages and under different conditions of keeping. The causative agent of strongyloidiasis develops well and is stored in livestock premises. Animals can be infected from the first days of life, more likely indoors, but also possible in yards or pastures under unsanitary conditions, due to increased humidity in the premises, which generally contributes to a decrease in the immune and biological reactivity of the organism [111, 181].

Considering the biology of *S. papillosus*, it is clear that the degree of invasion in farms is directly dependent on the conditions of keeping animals. Wet and dirty places, joint housing of animals of different age groups, accumulation of manure contribute to the rapid spread of strongyloidiasis and a rather high – 100% infection of young animals. On pastures infection with the causative agent of strongyloidiasis happens not often or at least is not high.

In some cases, taking into account the sanitary condition of livestock premises and the presence of eggs *of S. papillosus* can confirm the incidence of strongyloidiasis in animals [144].

As for the clinical signs of strongyloidosis, they are not very unique, but those that are characteristic of other diseases of different etiology. However, strongyloidiasis in young children occurs mainly in acute and chronic forms; in adult animals – subclinically [103]. Strongyloidiasis is an invasion, against the background of which diseases of other etiology run more acutely and with more noticeable pathology. Animals infested with *S. papillosus* in the conditions of stable keeping, after driving them to the pasture, are more intensively infected with strongylatosis.

Under unfavorable conditions of keeping animals indoors (dirty, large crowding, etc.), cases of acute enzootic disease can occur, which are accompanied by sharp weight loss and, in the absence of treatment, often end fatally. Subclinical strongyloidiasis in adult animals is asymptomatic.

During laboratory studies, to confirm the lifelong diagnosis of strongyloidiasis, generally accepted flotation methods of helmintoovoscopy using saturated salt solutions are used with high density (1.2 and higher). Ovoscopic methods are quite effective – according to Kotelnikov-Khrenov, Shcherbovich, Fülleborn, differentiating the eggs of Strongyloides from the eggs of Strongylates. Eggs *of S. papillosus* are light gray, oval with a thin, smooth, transparent shell, 0.045–0.054×0.025–0.33 mm in size with a larva inside that moves visibly. Later, after 2–5 h in the summer and 10–17 h in the cold season, after sampling, strongyloides eggs hatch into larvae, and then they must be differentiated by larvoscopic studies according to Berman, T.I. Popova or by the generally accepted cultivation of larvae in test tubes. Rhabditid-like larvae have one or two bulbs on the esophagus, they are small – 0.025–0.235 mm; filarial larvae are larger – 0.502–0.686 mm, characterized by the presence of a long cylindrical esophagus, quite mobile. According to these morphological characteristics of the larvae of *S. papillosus* can be distinguished from Strongylata larvae of intestines or respiratory organs [117, 137, 144, 180].

Postmortem, strongyloidosis is confirmed at autopsies and histological studies, taking into account specific changes in organ tissues. Pathological-anatomical changes and the results of coprological studies are used to differentiate pneumonia caused *by S. papillosu*, from respiratory diseases of other etiology [51, 87, 103].

Histological studies have established that granulomas form around the larvae that have penetrated the skin. An oxyphilic immune precipitate forms directly around the larvae, epithelioid cells accumulate, and then eosinophils and lymphoid cells [70, 184].

Thus, the diagnosis of strongyloidiasis is quite simple, but at the same time, it requires careful research. Since the clinical signs of this disease are non-pathognomonic, it is impossible to confirm the diagnosis based only on clinical manifestations. The complex of data from epizootological and laboratory studies, together with clinical signs, give the right to lifelong diagnosis. Final confirmation of strongyloidiasis is possible by identifying pathological and anatomical changes in the mucous membrane of the small intestine, internal organs, as well as the pathogens themselves [43].

Methods for diagnosing helminthiasis are reduced to the detection of pathogen eggs in feces or the cultivation of larval, invasive stages and their identification by morphological characteristics of each. Since the eggs of Strongyloides are released into the environment mature, i.e., they contain a larva, it is not difficult to differentiate them from the eggs of other types of helminths, especially when examining soot samples. Various flotation methods using saturated salt solutions are effective in these studies: according to Fülleborn, Shcherbovich, Kotelnikov-Khrenov. Achieving a high density of solutions (1.2 and higher) ensures sufficient efficiency of helmintoovoscopy.

In the case of larvoscopy, the larvae of *S. papillosus* are cultivated, feces are placed in Petri dishes, test tubes or beakers [182].

5.2. Improvement of the method of counting helminth eggs

Known methods of laboratory diagnosis of nematodes diseases in animals involve manipulation of feces, using flotation solutions to detect helminth eggs (helmintoovoscopy) or rearing larvae (helmintolarvoscopy) by culturing them under favorable conditions and differentiating them according to characteristic morphological features. However, there are certain disadvantages when using generally accepted or individual author's laboratory methods of counting the number of eggs. In some cases, they lack accuracy (the intensity of infestation is given in egg specimens in the field of view of a microscope, in a drop of a mixture of feces or in three to five drops), in others it takes a lot of time (in the case of using counting cameras), or requires recalculation of the number eggs per 1 g of feces, which is associated with the performance of rather burdensome mathematical calculations according to the proposed formulas [123, 137, 164]. A well-known method of counting helminth eggs in animal feces was proposed by V.N. Trach [164]. Its disadvantage is that it requires considerable time to recalculate the number of eggs found in the drops of the mixture from the loop to their number in the sample, taking into account the dimensions of the diameters of the areas of the glass and the helminthological loop. In addition, the research requires a considerable amount of time – 30–45 minutes, which is recommended for complete settling of fecal samples before the start of their research.

An improved, simpler but sufficiently accurate and convenient method of counting the number of eggs *of S. papillosus* (or other nematodes) in 1 g of feces. The proposed method, taking into account the generally accepted

elements of laboratory helminthological diagnostics, was carried out as follows (Fig. 5.1, 5.2): 1 g was taken from a sample of feces, placed in a beaker with a capacity of 30 ml, and 5 ml of a saturated solution of ammonium nitrate (ammonium nitrate) with a density of 1 ,3 and stirred until a homogeneous mixture was formed. After that, the mixture was filtered through a kapron strainer into another clean beaker with a "spout" and immediately poured into a test tube with a capacity of 5–8 ml, with straight walls and an inner diameter of 1–1.2 cm.

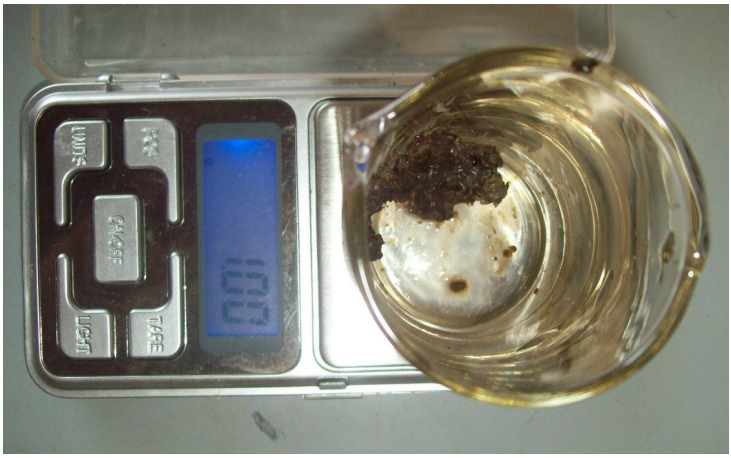


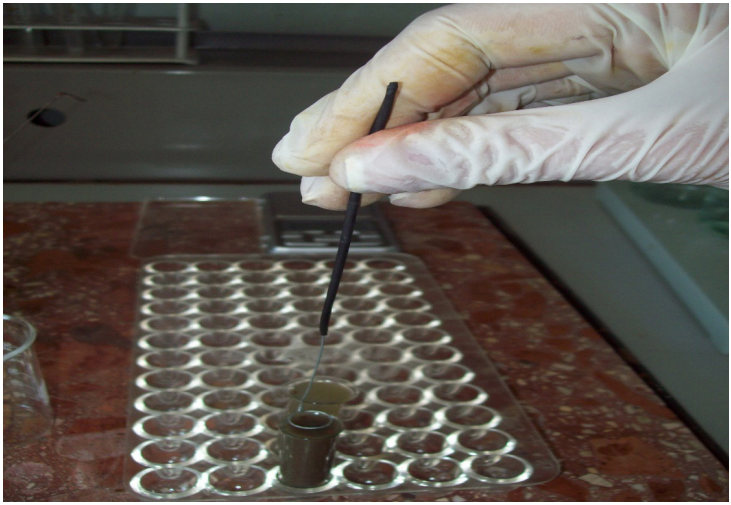
Figure 5.1. Fecal sample weight

If the test tube was not filled with the mixture, it was topped up to the level of the neck of the test tube, after rinsing the beaker, and allowed to stand for 20–25 min. After that, with a helminthological metal loop, 1 cm in diameter, made of thin (d = 0.3–0.5 mm) wire, the surface lamina of the liquid was removed from the mixture, placed on a glass slide, covered with a cover glass, viewed under a microscope, and the number was counted eggs.

The total number of helminth eggs in all fields of view, which fit in the test drop and is their number in 1 g of feces.

To determine the reliability of counting the number of helminth eggs, we conducted comparative studies of the number of eggs in 1 g of feces using the proposed method and the method of V.N. Trach. The number of eggs was counted according to the method of V.N. Trach, according to "Recommendations for the use of a new method of counting helminth eggs and protozoan cysts in animal feces" (1992).

(a)



(b)

Fig. 5.2. Preparation of fecal mixture (a) and removal of the surface lamina by helminthology loop d = 1 cm (b)

A total of 27 comparative studies of feces samples from calves aged 3–4 months, spontaneously affected by the causative agent of strongyloidiasis, which belonged to the private agricultural enterprise "Chumaky" were performed. Each study was carried out twice, repeating the calculations, for the reliability of the obtained results. The latter are listed in Table 5.1.

Table 5.1

Indicators of the number of eggs in 1 g of feces, n=54

# of samples	Number of eggs according to the method of V.N. Trach	Number of eggs according the offered method	# of samples	Number of eggs according to the method of V.N. Trach	Number of eggs according the offered method	# of samples	Number of eggs according to the method of V.N. Trach	Number of eggs according the offered method
1	32	28	10	30	21	19	36	29
	31	24		3 3	3 0		39	36
2	39	32	11	38	24	20	40	38
	37	24		36	28		42	37
3	44	31	12	3 8	3 4	21	39	35
	42	32		3 7	3 1		36	33
4	33	29	13	3 7	3 2	22	30	24
	31	27		34	29		36	31
5	29	21	14	3 9	3 1	23	35	22
	31	18		41	33		36	29
6	33	27	15	37	23	24	27	22
	35	31		35	26		25	16
7	34	23	16	36	29	25	29	27
	37	29		3 8	3 3		32	29
8	36	29	17	43	38	26	38	31
	35	34		3 6	3 0		30	23
9	32	23	18	2 7	2 4	27	39	36
	3 4	3 1		29	31		32	29
A total of 27							x ± SE 35.35 ± 6.66	x ± SE 28.20 ± 3.95

As can be seen from the indicators and average values of the number of Strongyloides eggs (x ± SE), counted by two different methods, the results of egg counting do not differ significantly (according to the method of V.N. Trach – by 7.1 units more), however, the proposed method is more accurate (has a smaller error). In addition, the method is performed faster in terms of the settling time of the mixture (20–25 min, instead of 30–45

min), and the calculation does not require the performance of a number of mathematical tasks according to formulas, which simplifies and facilitates obtaining the result.

Thanks to this, the proposed method can be widely used in practical laboratory diagnostics of strongyloidosis or other nematodes of the alimentary canal of animals during mass parasitological diagnostic studies of animals.

Thus, the proposed method of counting the number of helminth eggs in 1 g of feces using a helminthological loop with a diameter close to the diameter of the test tubes, as well as a saturated solution of ammonium nitrate, is more effective compared to the method of V. N. Tracha, due to the saving of execution time research, ease of implementation and effectiveness of determining the intensity of invasion [97].

5.3. Treatment and prevention of strongyloidiasis of ruminants

Pollution of the environment by invasive larvae requires scientific developments and the implementation of integrated methods of combating parasitosis. Currently, biological, mechanical, ecological-sanitary, technological, as well as immunological and genetic regulatory methods of control, with the reasonable use of chemical agents, have been developed and implemented [25, 26, 28-30, 32-34, 50, 75, 81, 122, 137, 145, 160].

Boyko et al. (2020) investigated the in vitro effect of aqueous tinctures of 48 species of herbaceous, shrubby and woody plants, which can be used as feed additives, on first-third stage larvae of *Strongyloides papillosus* and third-stage larvae of *Haemonchus contortus*. The highest level of effect was found by 3% aqueous tinctures of *Wisteria sinensis* (Sims) DC., *Ailanthus altissima* (Mill.) Swingle, *Laburnum anagyroides* Medik., *Quercus petraea subsp. iberica* (Steven ex M. Bieb.) Krasiln., *Ginkgo biloba* L., *Colchicum autumnale* L., *Aristolochia manshuriensis* Kom., *Celastrus scandens* L., *Securigera varia* (L.) Lassen, *Magnolia kobus* DC. More than 90% of the first and second non-invasive stages of *S. papillosus larvae* died when exposed to these tinctures. The authors established that the invasive larvae of *S. papillosus* and *H. contortus* were resistant to all 48 plant species used.

The complex of anti-parasitic measures aimed at breaking the "parasite-host" ties involves keeping animals on safe pastures and pastures, or according to a defined scheme of alternating their plots, grazing young

animals on separate pasture plots and constant monitoring of the epizootic situation [125, 131, 132, 138, 141].

Achieving the maximum recovery of the cattle herd from helminthiasis can be achieved by performing diagnostic helminthological studies during life, and postmortem by examining the internal organs during animal slaughter or veterinary-sanitary examination and correct rejection of them. Scientists advise to examine coproscopically during the year at least 10–12% of the cattle population [137]. Animals entering the farm should be quarantined, examined for helminthiasis, and those affected by any infestations should be dewormed.

Prevention of helminthiasis, including strongyloidiasis, should be aimed at destroying parasitic larvae at various stages of development in the environment. Disinfestation of livestock premises using chemical disinfectants is, nevertheless, the most widely used method of combating helminthiasis in the farms of the CIS countries. With the development of nanotechnology, it gains even greater priority due to the increased efficiency and environmental safety of new drugs [10, 11, 12, 13, 15, 142].

At the same time, it is important to increase the resistance of animals to infection by organizing hygienic conditions of keeping, ensuring adequate feeding and well-being of the territory of pastures [39, 149].

In recent years, researchers have increasingly paid attention to the study of the problem of active immunization of animals against helminthiasis. Its solution will be able to effectively prevent damage to animals by helminths. It is important to solve this issue by studying the mechanisms of allergy and immunity in invasive diseases [2]. In veterinary medicine, as well as in humane medicine, methods of immunizing organisms with invasive eggs, inactivated larvae, irradiated with X-ray γ-rays and purified antigens have been developed and tested, which are able to create intense immunity against the causative agents of some invasive diseases.

Successful fight against invasive diseases is possible only if highly effective medicines are available. Over the last decade, the country's research and production institutions have offered a significant number of new medicines. However, the market of Ukraine experienced significant saturation with expensive imported antiparasitic drugs [12]. Often, recommendations for their use are developed without taking into account the existing conditions of domestic production of livestock products, the epizootic situation, animal resistance, and the environmental impact of local factors. In specific cases, this is one of the reasons for their low efficiency [14, 185].

The use of chemical preparations does not always guarantee the achievement of a highly positive result, as well as the liberation of the animal's body from helminths. Even with effective treatment, the rapid death of pathogens leads to the release of a significant number of sensitizing products of their decomposition into the blood, which can lead to the development of complex immunopathological reactions [130]. At the same time, with high efficiency, anthelmintic drugs are able to show hepato- and neurotropic effects, cause leukocytosis, negatively affect hematopoiesis and cellular factors of immunity [57, 58]. The immunosuppressive effect of drugs based on benzimidazoles, in particular albendazole, fenbendazole, as well as tetramizole, has been experimentally confirmed in the practice of human and veterinary medicine [154, 177]. It has been proven that immunosuppression creates favorable conditions for the complication of helminthiasis with diseases of an associative nature, multiple super- and reinvasions [58, 73].

For various anthelmintic drugs are used for therapy and prevention of strongyloidiasis. The effect of medicinal products on helminths depends on a number of factors, in particular, on the chemical structure, dosage accuracy, routes of administration, duration of use, and the individual status of the animals. Such factors often interfere with the successful and timely diagnosis of invasive pathologies and definitely affect the effectiveness of antiepizootic measures [185, 88].

Anthelmintic drugs used to rid animals of strongyloidiasis pathogens should be broad-spectrum, since this helminthiasis is not only about the intestinal but also the larval, migrating form of the parasite [16].

Currently, the maximum percentage of dosage forms among drugs with complex (nematocidal and insecticidal and acaricidal) action are derivatives of groups of macrocyclic lactones – ivermectin and milbemycin. They have a wide spectrum of action on sexually mature and larval forms of nematodes, in therapeutic doses they do not have a negative effect on the body of animals and do not accumulate in livestock products [16, 36, 38].

A. V. Berezovsky confirms the high efficiency of derivatives of benzimidazole, avermectin and imidothiazole chemical groups, which exhibit a different mechanism of action on nematodes [16]. Benzimidazoles selectively affect cytoplasmic microtubules and cause the destruction of cellular organoids of the digestive tract of helminths, suppressing glucose absorption and slowing down ATP synthesis, which disrupts the energy exchange

of nematodes and causes their death. Avermectins are fermentation products of *Streptomyces actinomycetes avermitilis* , interfere with the transmission of nerve impulses between nerve and muscle cells of helminths by increased synthesis of the neurotransmitter γ -aminobutyric acid. The use of avermectins results in spastic paralysis and the evacuation of parasites from the alimentary canal of a sick animal [159, 166].

The fight against helminthiasis is greatly complicated by the unsystematic, "blind" or long-term use of anthelmintics, which contributes to the formation of parasite strains resistant to helminthicide drugs, increasing the drug resistance of parasites every time [14, 18, 76, 130, 178].

Modern researchers, taking into account the results of tests of anthelmintic drugs, offer clozalbene – the active substances of which are clozantel and albendazole – to combat nematodes of ruminants. Clozalbene is effective against mixed helminthiasis of ruminants caused by representatives of the classes of trematodes, cestodes, and nematodes resistant to benzimidazoles [65].

M.V. Kosenko, D.F. Gufrii and others believe that drugs from the group of tetrahydropyrimidines are also effective nematocidal anthelmintic agents. This group includes pyrantel (banmint, combantin – Pfizer, USA), which contains the active ingredient pyrantel tartrate, which is a depolarizing neuromuscular blocker and causes paralysis of mature and larval forms of nematodes and, at the same time, stimulates peristalsis of the animal's intestines. contributing to their expulsion from the body [65, 82]. Extensive efficiency of this drug for nematodes of cattle in a dose of 12.5 mg/kg reaches 79%.

The search for herbal anthelmintics is also relevant. The anthelmintic effectiveness of garlic, bitter wormwood, pumpkin seeds, male fern root extract, and tansy flower has long been known among many peoples. Modern researchers have confirmed the phytonematocidal activity of carrots, walnuts, lovage, oleander, St. John's wort, amaranth, and quinoa [94, 100].

In addition to anthelmintics, a number of authors recommend symptomatic treatment and the use of vitamins and immunomodulators in order to strengthen the immune status of animals, restore digestion, and promote the prevention of intestinal helminthiasis [69].

Treatment and prevention measures for strongyloidiasis should take into account the peculiarity of the pathogen's development in the environment and the presence of the migrating larval stage in the body of susceptible animals.

A high level of effectiveness of anthelmintic drugs in the fight against animal helminthiasis is the key to the effective improvement of livestock and ensuring its productivity. Success in the fight against helminthic invasions can be achieved with the correct selection and use of drugs that directly affect the "parasite-host" system and destroy it [13; 65, 130]. It is known [13, 177] that for a number of reasons of an objective and subjective nature, it is extremely difficult to achieve effective deworming in farms. Thus, the long-term use of the same drugs in the farm leads to the emergence of drug resistance in parasites, the different effectiveness of analogue drugs from different manufacturers, the ill-considered use of anthelmintics, etc., are often just such reasons.

At the same time, anthelmintics always remain relevant, since the development and implementation involve the study of their effectiveness, as well as the clarification of specific conditions and schemes of use each of them for various helminth infections [12].

Strongyloidiasis of animals still remains for a number of farms tangible a problem that requires a special approach from researchers in the development of preventive measures.

The effectiveness of the anthelmintic action of broad-spectrum drugs belonging to the group of benzimidazoles, whose active substance is albendazole, was evaluated, namely: albendazole ultra 10% (manufacturer of PP "O.L.KAR Agrozoovet-Service", Ukraine), albenvet (producer "Vetsyntez", Ukraine) and helmindazole-effect (producer of SE "Agrovetservice", Ukraine).

Research on determining the therapeutic effectiveness of selected anthelmintic drugs was conducted on animals that belonged to the agricultural private enterprise " Chumaky" of the Dnipropetrovsk district. For this purpose, we studied the level of infection with the causative agent of strongyloidiasis in animals of the control and experimental groups before deworming and 7, 14, 21, and 30 days after their treatment with anthelmintics according to the indicators of extensiveness and intensity of invasion, and based on the data obtained, the extensive and intensive effectiveness of the applied drugs was calculated.

According to the results of helmintoovoscopic studies carried out before deworming, it was found that the level of infestation by the causative agent of strongyloidiasis in the animals of the three experimental and control groups was 100%. The intensity of infestation in animals of all groups ranged from 32.3 ± 3.1 to 34.6 ± 1.2 eggs/g of feces (Table 5.2).

Table 5.2

Infestation of calves with *S. papillosus* before and after deworming, x ± SE

Groups of animals	Level of infestation of animals									
	before deworming		after deworming, days							
	EI, %	II, eggs/g of feces	EI, %				II, eggs/g of feces			
			7	14	21	30	7	14	21	30
The 1st experimental group n = 12	100	33.3 ± 4.2	33.3	16.7	8.3	0.0	26.1 ± 2.2	12.7 ± 0.8	2.1 ± 0.1	0.0
The 2nd experimental group n = 10	100	34.1 ± 2.1	30.0	10.0	10.0	10.0	22.1 ± 1.2	11.4 ± 1.3	2.1 ± 0.1	1.1 ± 0.1
The 3rd experimental group n = 12	100	34.6 ± 1.2	25.0	8.3	0.0	0.0	17.3 ± 1.4	8.2 ± 0.2	0.0	0.0
Control group n = 8	100	32.3 ± 3.1	100	100	100	100	34.3 ± 3.1	36.7 ± 4.8	36.4 ± 4.7	32.2 ± 1.8

*Notes: * EI – extensiveness of invasion, II – intensity of invasion*

After deworming, the animals of the research groups gradually became free of parasites. Thus, a week after feeding the drug Albendazole ultra 10%, eight calves of the first experimental group were completely freed from parasites, the extent efficiency was 66.7%. On the 14th day after deworming, eggs of *S. papillosus* were found in two calves, and on the 21st, only one out of 12 calves. Extensive efficiency reached 91.7%. On the 30th day of research, all calves of the first experimental group were freed from helminths (extensive efficiency and intensive efficiency were 100%).

After feeding Albenvet, on the seventh day, seven out of 10 affected calves were freed from *S. papillosus* (extensive efficiency = 70%). A week later, *S. papillosus* eggs were found in one calf of this group – the extent of the invasion was 10% and remained unchanged on the 21st and 30th days, with the intensity of the invasion – 2.1 ± 0.1 and 1.1 ± 0,1 eggs/g of feces, respectively.

Helmindazole-effect had a positive result in the third experimental group of calves. Thus, the extensiveness of the infestation already in the first study after deworming – on the 7th day had the lowest rate (25%), i.e., 9 out of 12 test calves were free from *S. papillosus*. On the 14th day, pathogen eggs were found in one calf (extensive efficiency 91.7%), and on the 21st day of research, the extensive efficiency was 100%. Coproscopic studies on the 30th day did not confirm the presence of Strongyloides eggs.

The intensity of the indicated anthelmintics testified to the positive effect of their action, as this indicator increased with each subsequent study, which confirmed a decrease in the number of eggs in fecal samples. Thus, on the seventh day of research in the calves of the first research group, the intensity of infestation was an average of 26.1 eggs/g of feces and decreased by 2.1 times on the 14th day, and on the 21st day it was lower by 24 instances (12.4 times) compared to its indicator on the seventh day after deworming and by 31.2 eggs from the level of damage to animals before they were given Albendazole ultra 10%. However, complete liberation of all animals from *S. papillosus* did not occur even in the third week after deworming. *S. papillosus* eggs were still detected in one calf of this experimental group , although the intensity of the infestation was low, amounting to 2.1 eggs/g of faeces. On the 30th day of research, the intensive efficiency reached 100%.

Feeding the calves of the second experimental group of albenvet was manifested by changes in the intensity of the invasion in the time periods planned by the experiment. Thus, on the seventh day, the intensity of invasion was 22.1 ± 1.2, which is 4% lower than after the use of albendazole

ultra 10%. The intensity of infestation decreased by almost two times on the 14th day of research (11.4 ± 1.3 eggs), and on the 21st it was 2.1 ± 0.1 eggs, which is 16.2 times less than before deworming . Remained minor infestation in one calf and on the 30th day after deworming.

However, in the third research group in terms of invasion intensity, already on the seventh day of research after the application of helmindazole-effect, the invasiveness was the lowest (17.3 ± 1.4 eggs). It actively decreased in the second week of research as well, after 14 days it amounted to 8.2 ± 0.2 eggs, which is 4.5 and 3.2 copies less than the calves of the first and second groups and 28.5 copies of eggs less, than in animals of the control group. On the 21st and 39th days, *S. papillosus eggs* were no longer found in the calves of this experimental group.

Thus, the effectiveness of the applied anthelmintics is positive, as evidenced by the indicators of extensiveness and intensity of invasion, which were obtained based on the results of coproscopic studies of the animals of the experimental and control groups. In the first and second experimental groups, on the 21st day of research, there was still one animal each (10%) in which a small number of *S. papillosus* eggs (2.1 eggs/g of feces) were detected. On the 30th day of research, the animals of the first and third research groups were free of *S. papillosus*. In the calves of the second group, the extensiveness of the infestation remained at the same level.

Evaluating the therapeutic effectiveness of anthelmintic drugs 7, 14, 21, and 30 days after treatment of calves with strongyloidosis, we confirmed their high antiparasitic effectiveness. Despite the fact that all the used drugs have the same active ingredient – albendazole, the most effective of them were albendazole ultra 10% and helmindazole-effect, and the latter was better in terms of the duration of the obtained effect.

The helminthicide effect of the drugs against *S. papillosus* was affected by certain dynamics (Table 5.3).

According to research results, albendazole ultra 10% and albenvet on the seventh day of research after deworming showed a fairly high efficiency, however, compared to helmindazole-effect, their indicators were 8.3 and 5% lower.

Two weeks after the treatment of the animals, the efficiency indicators changed. Thus, the extensibility of albendazole ultra 10% and helmindazole-effect increased from their previous indicators by 16.6 and 16.7%, amounting to 83.3 and 91.7%, respectively, while the effects of albenvet increased by 20%.

Table 5.3

Effectiveness of anthelmintics for strongyloidiasis in calves
(extensive effectiveness – EE, intensive effectiveness – IE, %)

Treatment period, days	The level of effectiveness of drugs					
	albendazole ultra 10%, (n = 12)		albenvet (n = 10)		helmindazole effect (n = 12)	
	EE	IE	EE	IE	EE	IE
7	66.7	21.2	70	35.2	75.0	83.3
14	83.3	61.7	90	66.5	91.7	93.8
21	91.7	93.7	90	93.8	100	100
30	100	100	90	93.8	100	100

The highest extensibility on the 21st day of research was achieved in the third experimental group after the administration of the helmindazole-effect to calves. In the other two experimental groups, the efficiency was also high (91.7% after the application of albendazole ultra 10% to the animals of the first experimental group and 90% after feeding albenvet to the second experimental group).

The indicators of intensive efficiency were particularly noticeable at the time of the first, after deworming, study in the animals of the third group and amounted to 83.3%, which is 62.1 and 48.1% higher than those in the calves of the first and second groups, respectively. On the 14th day after deworming, the indicators of intensive efficiency were 4.8% higher in the animals of the second group than after the effect of Albendazole-ultra 10%, but by 27.3% lower than the level of effectiveness of helmindazole-effect (93.8%). On the 21st day after feeding the drug, the indicators of intensity efficiency in the first two experimental groups of animals were practically the same, the difference was only 0.1% in favor of albenvet.

The results of ovoscopic studies on the 21st day after deworming with helmindazole-effect in the third experimental group had the highest indicators. Its extent and intensity efficiency were 100%.

On the 30th day of research after the treatment of animals, the highest indicators of the effectiveness of anthelmintics were in the first and third research groups. Thus, Albendazole Ultra 10%, Albenvet and Helmindazole-Effect are highly effective nematocidal drugs that allow to achieve the maximum extent efficiency (91.7, 90 and 100%) when animals are affected by the causative agent of strongyloidosis already three weeks after

their treatment. In this case, the intensity of the drugs was 93.7, 93.8 and 100%, respectively. The final result of the drugs still proved 100% effectiveness of two of the drugs taken for the experiment (albendazole ultra 10% helmindazole-effect).

However, we believe that deworming, which did not achieve 100% elimination of parasites from the body, creates favorable conditions for the formation of hidden foci of infestation. This is especially relevant for strongyloidosis, given the ability of its causative agents to develop in the environment.

It is known [84] that blood is one of the most labile tissues of a living organism. Changes in its composition have significant diagnostic value and characterize the level of functional capabilities of individual organs and systems, and therefore the body as a whole. Separate morphological indicators of blood make it possible to establish the presence of inflammatory processes, to assess the erythropoietic capacity of the bone marrow, as well as the level of allergy of the body. The biochemical composition of blood directly depends on the state of individual organs, the pathology of which, even in the absence of clinical signs, is revealed thanks to individual indicators. Undoubtedly, the course of strongyloidiasis in animals cannot but be reflected in the composition of the blood, and its study allows to comprehensively establish changes in the work of individual organs and systems during the development of the invasion and assess the negative impact on the body.

We conducted hematological studies of calves infected with the causative agent of strongyloidosis, confirming changes in morphological and biochemical parameters.

We studied hematological changes in the body of calves with strongyloidosis on the 14th and 30th days after deworming.

The development of pathological processes in the body of calves with strongyloidosis was reflected by certain destructive changes in the tissues of organs, as well as by violations of the morphological composition of blood. Thus, a decrease in the number of erythrocytes and hemoglobin content and an increase in the number of leukocytes were observed. Eosinophilia was noticeable. We noticed certain changes in the blood already two weeks after the use of anthelmintics (Table 5.4).

Thus, already on the 14th day, we noted a slight, but significant ($p<0.05$) increase in the hemoglobin content and, conversely, a decrease in the number of leukocytes and segmented neutrophils in the animals of the third group.

The increase in the number of erythrocytes in the animals of the first experimental group was also insignificant compared to the indicators in the control (by 0.3 T/l). An important confirmation of the weakening of the influence of helminths on the body of animals of all experimental groups was the decrease in the number of eosinophils. These indicators were more noticeable and reliable (from $p<0.05$ to $p<0.01$) in the first and third experimental groups. The number of eosinophils in the calves of these groups decreased by 5.6 and 6.9%, respectively.

Table 5.4

Morphological indicators of the blood of calves on the 14th day after the use of anthelmintics, x ± SE

Groups / Indicators	Control, n = 10	Research groups		
		the first n = 12	friend n = 10	the third n = 12
Hemoglobin, g/l	103.44 ± 2.63	107.52 ± 1.58	105.01 ± 1.05	109.82 ± 1.42*
Erythrocytes, T/l	5.62 ± 0.12	5.92 ± 0.04	5.22 ± 0.07	5.56 ± 0.16
Leukocytes, g/l	10.68 ± 1.24	9.86 ± 0.46	9.41 ± 0.67	8.86 ± 1.59
Basophils	0.73 ± 0.22	0.51 ± 0.23	0.35 ± 0.25	0.41 ± 0.21
Eosinophils	13.31 ± 0.24	7.74 ± 1.31*	8.32 ± 0.63	6.43 ± 0.31**
Neutrophils				
Neutrophils rod-shaped	3.42 ± 0.34	3.40 ± 0.34	3.95 ± 0.03	3.54 ± 0.26
Neutrophils segmented	19.89 ± 0.65	24,27 ± 0.86*	21.47 ± 0.86	24,41 ± 0.35*
Lymphocytes	59.81 ± 0.88	59,56 ± 0.78	61.11 ± 2.30	60.43 ± 1.68
Monocytes	3.68 ± 0.32	4.60 ± 0.42	4.76 ± 0.70	4.88 ± 0.24

*Notes. *p<0.05 – compared to control animals; **p<0.01 – compared to control animals.*

Changes in the morphological indicators of blood in the animals of the experimental groups on the 30th day of the experiment were more significant and indicated positive changes in their bodies (Table 5.5).

Thus, an increase in the hemoglobin content and the number of erythrocytes was noted in the animals of all experimental groups ($p<0.05$), compared to the indicators in the control animals, which indicates a gradual

restoration of the erythropoietic function of the red bone marrow after the release of the body from the toxic effects of helminths.

Table 5.5

Morphological indicators of the blood of calves on the 30th day after the use of anthelmintics, x ± SE

Groups / Indicators	Control, n = 10	Research groups		
		the first n = 12	friend n = 10	the third n = 12
Hemoglobin, g/l	98.83 ± 2.03	110.32 ± 3.38	109.63 ± 2.05	112.04 ± 0.44*
Erythrocytes, T/l	5.25 ± 0.17	6.24 ± 0.26	5.92 ± 0.17	6.23 ± 0.12
Leukocytes g/l	11.81 ± 0.90	8.36 ± 0.56**	8.23 ± 0.34***	8.21 ± 0.65***
Leukogram, %				
Basophils	0.92 ± 0.18	0.35 ± 0.29	0.42 ± 0.24	0.25 ± 0.25
Eosinophils	15,11 ± 2.28	4.84 ± 0.28***	6.09 ± 1.25***	4.01 ± 0.24***
Neutrophils				
rod nuclear	3.79 ± 0.42	6.31 ± 0.46**	7.39 ± 0.22**	6.65 ± 0.18**
segment nuclear	20.01 ± 0.48	23.84 ± 1.66	23.58 ± 1.96	22.51 ± 0.36
Lymphocytes	56,63 ± 2.61	59.65 ± 1.66	58,31 ± 1.12	60,72 ± 1.41
Monocytes	3.57 ± 0.41*	5.15 ± 0.65	5.23 ± 0.91	5.94 ± 0.62*

*Notes: *p<0.05 – compared to control animals; **p<0.01 – compared to control animals; ***p<0.001 – compared to control animals.*

There are significant changes in the number of leukocytes in the direction of their decrease, which to some extent indicates a decrease in inflammatory reactions caused by migrating larvae in the body of the animals of the experimental groups, after liberation from helminths.

In the animals of these groups, leukogram indicators normalized: eosinophilia disappeared, the number of rod- and segmented-nuclear neutrophils increased, which indicates an increase in leukopoiesis after the cessation of the toxic effects of Strongyloides and their larvae. In addition, the increase in the number of rod-shaped neutrophils reflects the process of gradual liberation of the body from the dead parasites after using drugs. Their number in the calves of the experimental groups increased by 1.7, 1.9, and 1.8 times, respectively.

Thus, the results of morphological studies of blood after deworming animals affected by Strongyloides indicate tangible positive changes in the process of normalization of the functions of their organism, freed from the influence of parasites.

The liberation of the calves of the experimental groups from the pathogenic effect of helminths was positively manifested on the indicators of the biochemical composition of the blood (Table 5.6).

Table 5.6

Biochemical indicators of blood in calves on the 14th day after deworming, x ± SE

Groups / Indicators	Control, n = 10	Research groups		
		the first n = 12	friend n = 10	the third n = 12
Total protein, g/l	83.34 ± 1.86	76.11 ± 2.34	77.98 ± 2.14	78.13 ± 2.94
Albumins, g/l	27,22 ± 1.84	33.17 ± 1.93	31.21 ± 2.61	34,42 ± 1.44
Globulins, g/l	56.11 ±0,14	42.93 ± 2.71	46,77 ± 2.23	43.69 ± 0.77
Albumins/ globulins	0.48 ± 0.07	0.77 ± 0.07	0.67 ± 0.03	0.79 ± 0.04
Glucose, mmol/l	3.02 ± 0.06	3.07 ± 0.05	3.05 ± 0.14	4.01 ± 0.04*

*Notes. *p<0.01 – compared to control animals.*

A comparison of indicators of the level of total protein in animals, sick and free from parasites, shows its decrease already on the 14th day. In the future, this indicator did not change significantly. Analysis of the fractional composition of proteins indicates a gradual increase in serum albumin content. On the 14th day after deworming, this indicator increased compared to the control.

The content of globulin fractions of protein after the use of drugs, in contrast to albumins, gradually decreased. In particular, after 14 days, it decreased on average by 13.18, 9.34 and 12.42 g/l by group of animals, respectively. The redistribution of protein fractions and the elimination of dysproteinemia had a positive effect on the value of the protein coefficient. It increased in the experimental animals, and on the 14th day after deworming, this indicator was reliable in the animals of the third experimental group ($p < 0.05$).

After the use of anthelmintics, the concentration of glucose in the blood of calves was restored, as a result of which hypoglycemia disappeared. However, this indicator in individual groups had its own characteristics. Thus, on the 14th day after the use of drugs, its level was restored only in calves of the 3rd experimental group.

Changes in the biochemical parameters of blood in the calves of the experimental groups on the 30th day after the use of anthelmintics were more noticeable (Table 5.7).

Table 5.7

Biochemical indicators of blood in calves on the 30th day after deworming, x ± SE

Groups / Indicators	Control, n = 10	Research groups		
		the first n = 12	friend n = 10	the third n = 12
Total protein, g/l	84.31 ± 1.66	75.24 ± 1.87*	76.42 ± 1.76*	76.83 ± 2.69*
Albumins, g/l	31,16 ± 2.33	36,12 ± 3.18*	39,11 ± 3.88*	39.02 ± 3.13**
Globulins, g/l	53.14 ± 3.87	39.08 ± 3.14*	37,31 ± 2.73*	37.78 ± 1.67*
Albumins/ globulins	0.58 ± 0.11	0.92 ± 0.13*	1.05 ± 0.07***	1.03 ± 0.21***
Glucose, mmol/l	3.01 ± 0.07	3.09 ± 0.04	4.01 ± 0.06**	4.02 ± 0.07**

*Notes. *p < 0.05 – compared to control animals; **p < 0.01 – compared to control animals; ***p<0.001 – compared to control animals.*

Thus, the indicator of the content of albumin fractions of total protein continued to grow and retained, as on the 14th day of the experiment, a similar difference with the control. The albumin content exceeded the control values in the animals of the first, second and third experimental groups. Such changes, probably in the albumin content, reflect the restoration of the functional activity of the organs of the alimentary canal, first of all, the intestinal epithelium. This, in turn, contributed to the growth of the body's assimilation of protein hydrolysis products.

The content of globulin fractions of protein continued to decrease until the 30th day of research its indicators were lower – by 14.06, 15.83 and 15.36 g/l, respectively, for the calves of the first, second and third experimental groups. Perhaps, as a result of freeing the body from parasites and

their larval stages, the antigenic load decreased, as a result of which the level of globulins decreased, the main part of which, as is known, is immunoglobulins.

The protein coefficient increased from the 14th day after the treatment of the animals and on the 30th day it reached the limits of normal values.

The return of the glucose concentration indicator to the physiological norm on the 30th day was observed in the animals of the second and third experimental groups. At the same time, under the influence of albendazole ultra 10%, during the experimental period, the indicator did not change and remained at the level of the control group. Perhaps this reflects a certain negative effect of the drug on the liver, where the processes of gluconeogenesis, glycogenesis and glycogenolysis take place, which ensure the necessary concentration of glucose in the blood. Analyzing the activity of blood transaminases, it is necessary to note a decrease in their activity throughout the entire period of research.

Changes in activity indicators of AST and ALT in the blood of calves on the 14th day after deworming are shown in table 5.8.

Table 5.8

Indicators of transaminase activity in calves on the 14th day after deworming, x ± SE

Groups / Indicators	Control, n = 10	Research groups		
		the first n = 12	friend n = 10	the third n = 12
JSC, Unit/l	85,29 ± 2.61	79.43 ± 2.76	74.12 ± 4.37	68.21 ± 2.34*
AlAT, Units/l	64,2 ± 0.51	62.7 ± 0.92	60.20 ± 1.13	57.73 ± 1,22

*Notes. *p < 0.01 – compared to control animals.*

This decrease was more noticeable, naturally, reflected in the activity of AST, since this enzyme is the most indicative of the level of cytolytic processes in hepatocytes. The decrease in ALT activity was less pronounced, but its indicators were reliable in the second and third experimental groups ($p < 0.05$).

More noticeable changes were recorded by us on the 30th day after deworming (Table 5.9).

Table 5.9

Indicators of transaminase activity in calves on the 30th day after deworming, x ± SE

Groups / Indicators	Control, n = 10	Research groups		
		the first n = 12	friend n = 10	the third n = 12
JSC, Unit/l	89.14 ± 3.87	72.44 ± 4.12*	70.64 ± 3.56*	60.12 ± 4.62***
AlAT, Units/l	63,68 ± 1.12	61,14 ± 1.02	54.6 ± 0.86*	53,11 ± 0.98**

*Notes. *p < 0.05 – compared to control animals; **p < 0.01 – compared to control animals; ***p<0.001 – compared to control animals.*

So, in particular, in the animals of the first; in the second and third experimental groups, AST activity decreased by 16.7, 18.5 and 29.02 % in accordance. Along with this, we also noted a decrease in the activity of ALT, which, however, was less pronounced and was likely on the 30th day after the use of drugs only in the calves of the second and third experimental groups.

The noted changes in the activity of AsAT and AlAT, first of all, should be associated with the restoration of the functional state of the liver after the elimination of the negative toxic effect of sexually mature Strongyloidiasis and their larvae. Taking into account that the dynamics of aminotransferase activity during the experiment was not equivalent by group, we can assume a certain negative effect of albendazole, first of all, on the liver of animals.

Thus, the dynamics of biochemical indicators in calves after deworming indicates a return to the physiological norm of protein metabolism in their body due to the increased synthesis of albumins in the liver and a decrease in the level of globulins, and also indicates the restoration of the functional activity of the liver. At the same time, of the studied drugs, albendazole ultra 10% had a sufficiently pronounced toxic effect, which was negatively reflected in hepatospecific biochemical indicators.

So, today there is no more important task for the agriculture of Ukraine than to meet the growing needs of the country's population for high-quality livestock products of its own production. To solve these issues, it is important to make full use of all the productive qualities embedded in the animal's body . One of the reserves for increasing the productivity of animals is their preservation, prevention and timely treatment of diseases,

including invasive ones. Parasitic diseases, which often occur in a subclinical form, lead to a decrease in body weight gain and the quality of meat and other types of productivity, and in the period of acute infestation, it is not uncommon for animals to die – especially young animals. According to literature data, it is known that parasitic diseases are common among young cattle in all livestock regions of Ukraine. Not the last place among them is strongyloidiasis, which is caused by the nematode *Strongyloides papillosus*. Invasion of calves by *S. papillosus* is certainly a very relevant issue, both in the CIS countries and in Ukraine.

Research on the issue of the epizootic situation of invasive diseases in the farms of Dnipropetrovsk region confirms that helminthiasis significantly affects cattle. Spread of strongyloidosis in farms with different methods of keeping animals – significant. The study of young cattle affected by this infestation in the farms of two regions of the region (Dnipropetrovsk and Zaporizhzhya) showed that strongyloidosis is a widespread infestation. An important role in the occurrence of invasion belongs to the biological mechanisms of the development of the epizootic process, the peculiarities of the pathogenic effect of parasites on the structure and functions of the organs of host animals, as well as the mechanisms of protection . Calves had different levels of damage depending on the methods of keeping. Thus, the average infestation in calves of individual farms was significantly (by 9.9%) lower than in production ones due to different ways of keeping them. This can probably be explained by the level of sanitary and hygienic conditions of keeping calves and their individual care. Despite the method of keeping the calves of production farms, no significant difference in the level of their infection with the causative agent of strongyloidosis was noted.

Research on the role of litter in animal husbandry premises, soil of pastures and walks in relation to the survival of invasive larvae confirmed their contamination not only by *S. papillosus* larvae, but also by intestinal Strongylata. Detection of eggs and invasive larvae in the samples confirmed, as best as possible, the probability of infection of animals with the causative agent of strongyloidosis both during the stable and pasture periods of their cultivation. In particular, more than 2.375 *S. papillosus larvae* in one kg were counted in the litter on which 3–4-month-old calves were kept. However, the study of soil samples of the territories near the livestock premises and near the walking yards (up to 2 m around) confirmed that they were free of *S. papillosus* eggs and larvae , which we explain by the

unfavorable conditions for their preservation: areas with dense soil, open to the effects of solar radiation and high or low temperatures. Studies of the soils of the pasture areas have confirmed that from the first days of the presence of cattle on them, the larvae are factors in the occurrence of strongyloidosis, as they remain viable in the soil from the fall and throughout the stable period. At the same time, the soils of farm pastures during the period of stable keeping of cattle, in contrast to the pastures where the animals of the owners of the private sector graze, are contaminated with more diverse helminth fauna.

The most affected calves are up to 6 months old, especially 3-4 months old (up to 100%). With age, the extensiveness and intensity of invasion decreases, which only partially coincides with the data provided by individual authors. The highest extent and intensity of the invasion occurred in the winter-spring period of the year. In the grazing period, the infection of animals decreased slightly, but it remained at a relatively high level during the warm period of the year. The reason for the difference in the indicators of seasonal dynamics of strongyloidosis in young cattle in various literary sources can probably be to some extent ecological, geographical and climatic factors.

Developing in the organism of the host animal, especially in the first period of life, helminths, as biological irritants, exert their pathogenic influence on it. The nature of this influence is diverse, it depends on a set of biological and physiological processes that occur during the development of the parasite, as well as on the protective properties and corresponding reactions of the host's organism. Despite the fact that characteristic, well-expressed clinical signs were not noted, we still observed some changes in the general condition of the animals. It was a noticeable, but short-lived increase in body temperature, breathing rate and pulse, impaired function of the digestive tract. Hyperemia, punctate hemorrhages in the form of wounds (places of possible penetration of *S. papillosus* larvae percutaneously), and some restlessness were noticed on the skin of the calves' abdomens. A significant decrease in the hemoglobin content and a decrease in the number of erythrocytes was noted in calves spontaneously affected by the causative agent of strongyloidiasis. The reason for such changes is the toxic effect of helminths on the animal body, during which inhibition of the erythropoietic activity of the bone marrow was observed against the background of chronic intoxication. As a result, anemia developed. A significant increase in the number of leukocytes in animals is associ-

ated with the development of inflammatory processes that occurred due to mechanical injuries to the tissues of internal organs migrating larvae of *S. papillosus*. Leukocytosis was accompanied by significant changes in the leukogram. Persistent eosinophilia was noted. The number of lymphocytes in the blood of sick animals differed significantly from the indicators in the control. Lymphocytes take an active part in the implementation of immunological reactions, perform an antitoxic function. They produce humoral factors that stimulate tissue regeneration of internal organs. The changes in the leukogram noted by us indicate suppression of the resistance of the animal body to various antigenic stimuli against the background of strongyloidiasis. Similar to the number of lymphocytes, the proportion of segmented neutrophilic leukocytes also decreased in infected calves. The appearance of young neutrophils in the bloodstream against the background of pronounced neutropenia indicates a violation of the maturation of neutrophil forms in the hematopoietic centers of the neutrophil population. Given that neutrophils are considered the most active forms of phagocytic blood cells, it can be assumed that the cellular link of immunity is also suppressed during the development of the disease. A decrease in their number indicates a lack of protective ability in this population of cells. Obviously, the noted changes characterize the toxic effect on the myeloid tissue of the red bone marrow. In addition, part of the functions of neutrophil leukocytes can be performed by eosinophils, which are also capable of phagocytosis. An increase in the number of monocytes was noted during the development of strongyloidiasis in calves. Given that these blood cells have a pronounced macrophage reaction and participate in immune defense reactions, we considered the development of monocytosis as a compensatory reaction to neutropenia and lymphopenia.

Caused by mechanical damage to body tissues by migrating larval stages and their inoculating effect and parasitism of mature *S. papillosus* in the intestine, which became the factors of inflammatory phenomena in their body. At the same time, the main link in the pathogenesis of strongyloidiasis is, most likely, the toxic effect of parasites, which leads to suppression of erythropoiesis and, to a certain extent, the organs of immune protection.

Structural and histological changes in the calf's organs were noted during the pathological autopsy, which confirmed the pathogenic influence of both larval migratory stages and mature hermaphrodite individuals. Mechanical injury to the mucous membrane of the small intestine caused

hyperemia in the places of direct placement and migration of helminths. The formation of hemorrhages and spot hemorrhages indicated the mechanical impact of *S. papillosus*. Histological studies confirmed that the most significant damage occurred in the architecture of the mucous membrane at the level of intestinal villi: their destruction with the formation of necrotic detritus on the surface of the mucous membrane was noted. In some places, diffuse lymphoid-histiocytic infiltration of the intestine was noted walls and growth of fibrous tissue in inflamed areas of the mucous membrane. Regional and mesenteric lymph nodes are slightly enlarged, swollen, on the section – saturated, moist, dense, the surface of the section is convex, sometimes with dotted hemorrhages, shiny. The cause of their injury is probably related to the migration of larvae. Histosections show eosinophilic and lymphocytic infiltration against the background of rarefaction of the general cellular composition. In different areas of the lungs, the changes were heterogeneous. Macroscopically, foci of hyperemia and stasis in blood vessels were detected, which apparently arose for the same reason as in other organs – the mechanical impact of *S. papillosus* larvae. Atelectasis lesions and areas of compensatory emphysema were visible in the histological studies of sections from the affected tissues of the organ. Thus, pronounced pathomorphological changes occur in the body of calves, which are caused by both mechanical and toxic effects of mature helminths and their larvae.

Our research established that sexually mature *S. papillosus*, as well as larval homogenates and their lifelong secretions in the Ames test show a mutagenic effect and can induce reverse gene mutations to histidines of independence in strains of *S. typhymurium* TA–98 and TA–100 by type of frameshift and type of base pair substitution. Using the micronucleus test, which is one of the cytogenetic methods of rapid assessment of genetic risk xenobiotics in vivo in mammals it was established that the invasion of *S. papillosus* and their lifelong secretions show a mutagenic effect on the chromosomal apparatus of somatic cells of non-linear white rats, which leads to a probable increase in the number of erythrocytes with micronuclei.

Long-term diagnosis of strongyloidiasis is carried out by detection of eggs *of S. papillosus* by flotation methods no later than 5 hours after fecal sampling or larval rearing. In Ukraine, for counting the number of eggs in samples, the method, in particular, proposed by V.N. Trach, is used quite often – with the performance of a number of mathematical calculations.

Our proposed method of counting eggs in animal feces differs in that the initial sample of feces has a mass of 1 g, and the surface film is removed in a tube with an inner diameter close to the diameter of a helminthological loop (1 cm). In addition, the time for settling the mixture of feces is reduced – to 20-25 minutes (instead of 30-45 minutes in the method of V. N. Trach) and, actually, the counting of eggs, without significant mathematical calculations. As evidenced by the results of counting eggs in 1 g of feces according to the method of V.N. Trach and the proposed method do not differ significantly, but the proposed method is more accurate (has a smaller error). Due to this, the method can be widely used for lifelong diagnosis of helminthiasis, including strongyloidiasis, in animals during mass parasitological studies.

The application of anthelmintics to infested calves and the analysis of their therapeutic effectiveness showed that the drugs (Albendazole Ultra 10%, Albenvet and Helmindazole-Effect), which were used to treat the animals of the research groups, helped to improve their general condition and rid the body of parasites. The effectiveness of Albenvet was slightly lower compared to the other two anthelmintics. We believe that deworming, which did not achieve 100% elimination of parasites from the body, contributes to an imperceptible, chronic course and the formation of hidden foci of infestation. This is especially relevant for strongyloidosis , the causative agent of which is capable of developing in the environment. Thus, albendazole ultra 10% and helmindazole-effect achieved high therapeutic effectiveness – extends effectiveness and intensity effectiveness – 100% when animals were affected by the causative agent of strongyloidosis. Although Albenvet had a positive effect on ridding animals of helminths, it did not reach the highest indicators. The hematological indicators of the calves confirmed the improvement of their general condition. Thus, already on the 14th day after deworming with Helmindazole-effect, a significant ($p<0.05$) increase in the hemoglobin content in the blood was noted in the animals. The number of erythrocytes increased slightly compared to the indicators in control animals and, conversely, the number of leukocytes and segmented neutrophils decreased. An important confirmation of the weakening of the influence of helminths on the body of animals of all experimental groups was the decrease in the number of eosinophils.

Changes in the morphological indicators of blood in the animals of the experimental groups on the 30th day of the experiment were more significant and indicated positive changes in their bodies. An increase in

the hemoglobin content and the number of erythrocytes in animals of all experimental groups was noted ($p<0.05$), compared to the indicators in control animals. The identified changes indicate the gradual restoration of the erythropoietic function of the red bone marrow after the body is freed from the toxic effects of helminths. Significant changes in the number of leukocytes in the direction of their decrease, to a certain extent, indicate a decrease in inflammatory reactions caused by migrating larvae in the body of the animals of the experimental groups, after they were freed from helminths. In the animals of these groups, the leukogram indicators were normalized: eosinophilia disappeared, the number of rod-shaped and segmented neutrophils increased, which indicates an increase in leukopoiesis after the cessation of the toxic effect of *S. papillosus* and their larvae. We believe that the increase in the number of rod neutrophils in the calves of the experimental groups reflects the process of gradual liberation of the body from dead parasites after the use of drugs. The liberation of the calves of the experimental groups from the pathogenic influence of helminths was positively manifested on the indicators of the biochemical composition of the blood.

A comparison of indicators of the level of total protein in animals, sick and free from parasites, showed its decrease. Analysis of the fractional composition of proteins indicated a gradual increase in serum albumins. This indicator continued to grow. In our opinion, such changes reflect the restoration of the functional activity of the organs of the alimentary canal, primarily the intestinal epithelium. This, in turn, contributed to the growth of the body's assimilation of protein hydrolysis products. It is known that albumin neutralizes or mitigates the toxic effect of the waste products of migrating larvae and adult helminths. Since albumin is completely synthesized in the liver, an increase in its level indicates an increase in the albumin-synthesizing function of the liver. The content of globulin fractions of protein after the use of drugs, in contrast to albumins, gradually decreased. This was probably the result of the body getting rid of parasites, which contributed to a decrease in the antigenic load and, as a result, led to a decrease in globulins. With the elimination of dysproteinemia, there were positive changes in the value of the protein coefficient.

After the use of anthelmintics, the concentration of glucose in the blood of calves was restored, as a result of which hypoglycemia disappeared. However, this indicator in individual groups had its own characteristics. At the same time, under the influence of albendazole ultra 10%, during

the experimental period, the indicator did not change and remained at the level of the control group. Perhaps this reflects a certain negative effect of the drug on the liver, where the processes of gluconeogenesis, glycogenesis and glycogenolysis take place, which ensure the necessary concentration of glucose in the blood.

Analyzing the activity of blood transaminases, it is necessary to note a decrease in their activity throughout the entire period of research. This decrease was more noticeable, naturally, reflected in the activity of AsAT, since this enzyme is the most indicative of the level of cytolytic processes in hepatocytes. The decrease in ALT activity was less pronounced, but its indicators were reliable in the second and third experimental groups. The noted changes in the activity of AST and ALT, first of all, should be associated with the restoration of the functional state of the liver after the elimination of the negative toxic effect of sexually mature *S. papillosus* and their larvae. Taking into account that the dynamics of aminotransferase activity during the experiment was not equivalent by group, we can assume a certain negative effect of albendazole, first of all, on the liver of animals. Thus, the results of morphological studies of blood after deworming of animals indicate tangible positive changes in the process of restoring the functions of their organism, freed from the influence of parasites. The dynamics of biochemical indicators in calves after treatment with anthelmintics indicates the return of protein metabolism to the physiological norm due to the increased synthesis of albumins in the liver and a decrease in the concentration of globulins, and also indicates the restoration of the functional activity of the liver. At the same time, of the studied drugs, albendazole ultra 10% had a sufficiently pronounced toxic effect, which was negatively reflected in hepatospecific biochemical indicators. It was found that the deworming had a positive effect on average daily body weight gains in calves spontaneously infected with *S. rarillosus*. At the same time, the use of helmindazole-effect and albendazole ultra 10% was more effective. The extent and intensity effectiveness of both drugs was 100%.

The conducted studies made it possible to estimate the spread of strongyloidosis in calves in farms with different methods of keeping. The obtained results can be included in monitoring data on helminthic invasions of cattle and prediction of strongyloidosis in individual farms by state institutions of veterinary medicine; they should be used during classes on parasitology and invasive diseases in agricultural educational institutions.

REFERENCES

1. Anderson R. S. Nematode Parasites Their Development and Transmission 2-nd Edition / CABI Publishing Wallingford, Oxon, UK 2000. – P. 19–31.
2. Annual report to The Danish National Research Foundation // Danish Centre for Experimental Parasitology [Electronic resource]. – 2001. – Access mode: http: //www.ivp.life.ku.dk.
3. Apatenko V. M. (2005). Obshhaya parazitocenologiya [General parasitocenology]. – Kharkiv, Consum, – 151 p. (in Ukrainian).
4. Ashford R. W., Barnish G. B. (1989). *Strongyloides fuelleborni* and similar parasites in animals. In: *Strongyloidiasis* a major roundworm infection of man, D. I. Grove, ed. (London: Taylor and Francis), – P. 271–286.
5. Ashford R. W. Barnish G., Viney M. E. (1992). *Strongyloides fuelleborni* kellyi: Infection and disease in Papua New Guinea. Trends Parasitol, 8, – P. 314–318.
6. Ashton F. T., Schad G. A. (1996). Amphids in *Strongyloides stercoralis* and other parasitic nematodes. Trends Parasitol, 12, – P. 187–194.
7. Ashton F. T., Bhopale V. M., Fine A. E., Schad G. A. (1995). Sensory neuroanatomy of a skin-penetrating nematode parasite *Strongyloides stercoralis*. I. Amphidial neurons, J. Comp. Neurol, 357, – P. 281–295.
8. Ashton F. T., Bhopale V. M., Holt D., Smith G., Schad G. A. (1998). Developmental switching in the parasitic nematode *Strongyloides stercoralis* is controlled by the ASF and ASI amphidial neurons. J. Parasitol, 84, – P. 691–695.
9. Bekish Vl. J. (2000). The influence of larvas metabolites of *Ascaris suum* on genom of host in reinvasion. Acta Parasitologica, 45 (3), – P. 243.
10. Berezovskiy A. V. (1996). Virobnictvo antigelmintnih zasobiv v Ukrayini [The incidence of anthelmintic diseases in Ukraine]. Veterinary medicine of Ukraine, 3, – P. 53 (in Ukrainian).
11. Berezovskiy A. V. (2002). Vivchennya mutagennoyi aktivnosti novih kombinovanih antigelmintikiv [Evidence of mutagenic activity of new combinations of anthelmintics]. Veterinary medicine of Ukraine, 2, – P. 15–16 (in Ukrainian).

12. Berezovskiy A. V. (2000). Vprovadzhennya suchasnih importozaminnih preparativ dlya terapiyi invazijnih hvorob tvarin [Introduction of modern import-substituting drugs for the treatment of invasive animal diseases]. Creation of Ukraine, 3 (4), – P. 19–20 (in Ukrainian).
13. Berezovskiy A. V. (2000). Likarski preparati novogo pokolinnya dlya veterinarnoyi medicini [Pharmaceutical preparations of a new generation for veterinary medicine]. – Kyiv, Vetinform, 86 p. (in Ukrainian).
14. Berezovskiy A. V. (2000). Likoopirnist parazitiv ta deyaki shlyahi yiyi podolannya [Resistance of parasites and some ways to overcome it]. Veterinary medicine of Ukraine, 3, – P. 33–34 (in Ukrainian).
15. Berezovskiy A. V. (2002). "Brovadez-20" yak dezinvazijnij zasib ["Brovadez-20" as a disinfectant]. Veterinary medicine of Ukraine, 6, – P. 27–28 (in Ukrainian).
16. Berezovskiy A. V. Teoretichni i praktichni osnovi stvorennya likarskih form himioterapevtichnih preparativ dlya terapiyi ta profilaktiki invazijnih hvorob tvarin [Theoretical and practical bases of creation of dosage forms of chemotherapeutic drugs for therapy and prevention of invasive animal diseases]: avtoreferat thesis is presented for conferring a scientifc degree of Doctor of Veterinary Sciences on a speciality 16.00.11. – Parasitology, Helminthology. – Kharkiv, 2003. - 36 p. (in Ukrainian).
17. Bodnya E. I. (2006). Rol parazitarnyh invazij v razvitii patologii organov pishhevareniya [The role of parasitic invasions in the development of food pathology]. Modern gastroenterology, 3 (29), - P. 56–62 (in Ukrainian).
18. Boyko O. O. (2008). Zalezhnist glibini migraciyi lichinok nematod pidryadiv Strongylata i Rhabditata vid mehanichnogo skladu gruntu [Dependence of depth of migration of larvae of nematodes of contracts Strongylata and Rhabditata on mechanical composition of soil]. Scientific and technical bulletin of the Institute of Animal Biology and DNDKI of veterinary drugs and feed additives, 9 (4), - P. 117–121 (in Ukrainian).
19. Boyko O. O. (2008a). Kontaminaciya pasovishh Pridniprov'ya lichinkovimi stadiyami nematod pidryadiv Strongylata i Rhabditata [Contamination of Prydniprovye pastures by larval stages of nematodes of the contracts Strongulata and Rhabditata]. Bulletin of Zaporizhia National University: Issues of bioindication and ecology, 13 (1), - P. 119–125 (in Ukrainian).

20. Boyko O. O. (2008b). Zalezhnist rozvitku lichinok nematod pidryadiv Strongylata i Rhabditata vid rivnya zasolenosti gruntu [Dependence of development of larvae of nematodes of contracts Strongylata and Rhabditata on the level of soil salinity]. Bulletin of Dnipropetrovsk National University. Biology. Ecology, 16 (2), - P. 8–11 (in Ukrainian).
21. Boyko O. O. (2009). Ekolohichni osoblyvosti lychynok nematod pidriadiv Strongylata i Rhabditata u bioheotsenozakh stepovoho Prydniprovia [Ecological features of nematode larvae of the suborders Strongylata and Rhabditata in biogeocenoses of the Dnieper steppe]. XIV Conference of the Ukrainian Scientific Society of Parasitologists (UNTP) [Parasites and parasitoses: modernity and risks], (September 21–24, 2009). – Uzhgorod: Uzhgorod National University. – P. 13 (in Ukrainian).
22. Boyko O. O. (2015). Helmintofauna ovets i kiz Dnipropetrovskoi oblasti [Helminth fauna of sheep and goats of the Dnipropetrovsk region]. Bulletin of the Dnipropetrovsk University. Biology. Medicine, 6 (2), – P. 87–92 (in Ukrainian).
23. Boyko A. A., & Brygadyrenko V. V. (2016). Influence of water infusion of medicinal plants on larvae of Strongyloides papillosus (Nematoda, Strongyloididae). Visnyk of Dnipropetrovsk University, Biology, Ecology, 24(2), – P. 519–525. https://doi.org/10.15421/011670
24. Boyko O. O., & Brygadyrenko V. V. (2018). The impact of certain flavourings and preservatives on the survivability of larvae of nematodes of Ruminantia. Regulatory Mechanisms in Biosystems, 9(1), – P. 118–123. https://doi.org/10.15421/021817
25. Boyko O. O., Gugosyan Y. A., Shendryk L. I., & Brygadyrenko V. V. (2019). Intraspecific morphological variation in free-living stages of Strongyloides papillosus (Nematoda, Strongyloididae) parasitizing various mammal species. Vestnik Zoologii, 53(4), – P. 313–324. https://doi.org/10.2478/vzoo-2019-0030
26. Boyko O. O., Brygadyrenko V. V. (2019a). Nematocidial activity of aqueous solutions of plants of the families Cupressaceae, Rosaceae, Asteraceae, Fabaceae, Cannabaceae and Apiaceae. Biosystems Diversity, 27(3), – P. 227–232. https://doi.org/10.15421/011931
27. Boyko O. O., & Brygadyrenko V. V. (2019b). The viability of Haemonchus contortus (Nematoda, Strongylida) and Strongyloides papillosus (Nematoda, Rhabditida) larvae exposed to concentrations of flavourings and source materials approved for use in and on foods. Vestnik

Zoologii, 53(5), – P. 553–562. https://doi.org/10.2478/vzoo-2019-0044
28. Boyko O. O., & Brygadyrenko V. V. (2019c). The impact of acids approved for use in foods on the vitality of Haemonchus contortus and Strongyloides papillosus (Nematoda) larvae. Helminthologia, 56(3), – P. 202–210. https://doi.org/10.2478/helm-2019-0017
29. Boyko O. O., Kabar A. M., & Brygadyrenko V. V. (2020). Nematicidal activity of aqueous tinctures of medicinal plants against larvae of the nematodes Strongyloides papillosus and Haemonchus contortus. Biosystems Diversity, 28(1), – P. 119–123. doi:10.15421/012016
30. Boyko O. O., & Brygadyrenko V. V. (2021a). Nematicidal activity of synthetic food colorings. Fresenius Environmental Bulletin, Volume 30 – No. 06B/2021, 7743-7749
31. Boyko O. O., & Brygadyrenko V. V. (2021b). Nematicidal activity of essential oils of medicinal plants. Folia oecologica, 48(1), – P. 42–48. doi: 10.2478/foecol-2021-0005
32. Boyko O. O., & Brygadyrenko V. V. (2021c). Nematicidal activity of aqueous tinctures of plants against larvae of the nematode Strongyloides papillosus. Tropical Biomedicine, 38(2), – P. 1–9. https://doi.org/10.47665/tb.38.2.046
33. Borau J. C. Rolf R. F. (1994). Anthelmintic resistant in helmints: a dynamic global problem. Abstr. of the 8-th Inter. Congress of Parasitol., Izmir – Turkey, 1, – P. 27.
34. Borisenko V. S. (1978). Strongiloidoz i osobennosti ego jepidemiologii v stepnoj zone Pridneprovya [Strongyloidiasis and features of its epidemiology in the steppe zone of the Dnieper region]: avtoreferat thesis is presented for conferring a scientifc degree of candidate of medical sciences on a speciality 14.00.30. – Epidemiology. – Kyiv, – 22 p. (in Ukrainian).
35. Bundza A., Gardiner C. H. (1990). Larval parasites in limph nodes of slaunghter cattle. J. of Comparative Pathology, 103(2), – P. 233–236.
36. Burg P. W., Strepley E. O. (1989). Isolation and characterization of the producting organism. Ivermectin and abamectin. Cambell W. C. Ed. – New York – Springer Verlag, – P. 24–32.
37. Carvalho E. M., Da Fonseca Porto A. (2004). Epidemiological and clinical interaction between HTLV-1 and *Strongyloides stercoralis*. Parasite Immunol, 26, – P. 487–497.

38. Charlier, J., Thamsborg, S. M., Bartley, D. J., Skuce, P. J., Kenyon, F., Geurden, T., … Claerebout, E. (2017). Mind the gaps in research on the control of gastrointestinal nematodes of farmed ruminants and pigs. Transboundary and Emerging Diseases, 65, – P. 217–234. doi:10.1111/tbed.12707
39. Chornyi M. V., Lolia V. V., Sipityi A. I. (2007). Litno-tabirne utrymannia velykoi rohatoi khudoby [Summer camp maintenance of cattle]. Veterinary medicine of Ukraine, 7, – P. 10–11 *(in Ukrainian).*
40. Cimino M. C. (1991). New micronucleus guideline for the U.S. environmental protection agency. U.S. EA, office of Toxic Substances, Health and Environmental Review Division, Washington DC. Mutat. Res. Envir. and Mol. Mutagen, 17, Suppl. 19, – P. 83.
41. Couvillion C.E., Siefker C., Evans R. R. (1996). Epidemiological study of nematode infections in a grazing beef cow-calf herd in Mississippi. Veterinary Parasitology, 64 (3). – P. 207–218.
42. Dahno I. S., Dahno G. P. (2010). Ekologichna gelmintologiya / I.S. Dahno, [Ecological helminthology]. – Sumy, Kozatsky Val Publishing House, – 220 p. (in Ukrainian).
43. Dawkins H. J. S., Robertson T. A, Papadimitriou J. M., Grove D. I. (1983). Light and electron microscopical studies of the location of *Strongyloides ratti* in the mouse intestine. Parasitol. Res, 69, – P. 357–370.
44. Dorris M., Viney M. E., Blaxter M. L. (2002). Molecular phylogenetic analysis of the genus *Strongyloides* and related nematodes. Int. J. Parasitol, 32, – P. 1507–1517.
45. Dovhiy Yu. Yu. Fascioloz velikoyi rogatoyi hudobi v umovah trivalogo vplivu ionizuyuchogo viprominyuvannya (epizootologiya, patogenez ta likuvannya) [Fasciolosis of cattle under conditions of prolonged exposure to ionizing radiation (epizootology, pathogenesis and treatment)]: avtoreferat thesis is presented for conferring a scientifc degree of Doctor of Veterinary Sciences on a speciality 16.00.11 – Parasitology. –2005. – 34 p. (in Ukrainian).
46. Dyomkina O. V. Strongiloidoz krupnogo rogatogo skota i mery borby s nim v Amurskoj oblasti [Strongyloidosis in cattle and measures to combat it in the Amur Region]: avtoreferat thesis is presented for conferring a scientifc degree of candidate of medical sciences on a speciality 03.00.19 – Cryobiology, – 2006. – 18 p.

47. Eberhardt A. G., Mayer W. E., Streit A. (2007). The free-living generation of the nematode *Strongyloides papillosus* undergoes sexual reproduction. Int. J. Parasitol, 37, – P. 989–1000.
48. Fenech M., Holland N., Chang W. P., Zeiger E., Bonassi S. (1999). The Human MicroNucleus Project – An international collaborative study on the use of the micronucleus technique for measuring DNA damage in humans. Mutat. Res. Fund, and Mol. Mech. of Mutagen, 428, – P. 271–283.
49. Fisher M. C., Viney M. E. (1998). The population genetic structure of the facultative sexual parasitic nematode *Strongyloides ratti* in wild rats. Biol. Sci., 265, – P. 703–709.
50. Galat V. F. (1998). Invazijni hvorobi: profilaktika ta likuvannya [Invasive diseases: prevention and treatment]. – Veterinary medicine of Ukraine, 4, – P. 42–43 (in Ukrainian).
51. Galat, V. F., Berezovskyi A. V., Soroka N. M. (2004). Metodychni vkazivky z diahnostyky helmintoziv tvaryn [Guidelines for the diagnosis of animal helminthiasis]. – Kyiv: Vetinform, – 56 p (in Ukrainian).
52. Galat V. F. (2009). Morfologiya gelmintiv tvarin: atlas [Morphology of animal helminths: atlas]. – Poltava, Publishing House "Poltava", – 100 p. (in Ukrainian).
53. Gardner M. P., Gems D., Viney M. E. (2004). Aging in a very short-lived nematode. Exp. Gerontol., 39, – P. 1267–1276.
54. Gardner M. P., Gems D., Viney M. E. (2006). Extraordinary plasticity in aging in *Strongyloides ratti* implies a gene-regulatory mechanism of lifespan evolution. Aging Cell, 5, – P. 315–323.
55. Genta R. M., (1989). Pathology. In *Strongyloidiasis* a major roundworm infection of man. D. I. Grove, ed. (London: Taylor and Francis), – P. 105–132.
56. Horalskyi L. P. (2005). Osnovi gistologichnoyi tehniki i morfo-funkcionalni metodi doslidzhen u normi ta pri patologiyi [Fundamentals of histological technique and morpho-functional research methods in normal and pathology]. – Zhytomyr, Polissya, – 288 p. *(in Ukrainian).*
57. Gricik O. B. (2001). Vpliv strongiloyidozno-strongilyatoznoyi invaziyi na imunologichni pokazniki ovec [Influence of strongyloidiasis-strongylatosis invasion on immunological parameters of sheep]. Scientific Bulletin of LDAVM named after SZ Gzhytsky. – Lviv, –3 (2), P. 23–26 (in Ukrainian).

58. Grishko E. N. (2005). Sravnitelnaya ocenka vliyaniya raznyh sposobov lecheniya na nekotorye gematologicheskie pokazateli u telyat pri jejmerioze [Comparative evaluation of the effect of different methods of treatment on some hematological parameters in calves with eimeriosis]. Materials of the international scientific-practical conference Troitsk: UGAVM, – P. 37–40 (in Ukrainian).
59. Gill G. V. A., Beeching N. J., Khoo S., Bailey J. W., Partridge S. , Blundell J. W., Luksza A. R. (2004). British Second World War veteran with disseminated strongyloidiasis. Trans. R. Soc. Trop. Med. Hyg, 98, – P. 382–386.
60. Grant W. N., Stasiuk S., Newton Howes J., Ralston M., Bisset S. A., Heath D. D., Shoemaker C. B. (2006). Parastrongyloides trichosuri, a nematode of mammals that is uniquely suited to genetic analysis. Int. J. Parasitol., 35, – P. 453–466.
61. Grove D. I. (1989). Clinical manifestations. In *Strongyloidiasis* a major roundworm infection of man. D. I. Grove, ed. (London: Taylor and Francis), – P. 155–174.
62. Grove D. I. (1989). Treatment. In *Strongyloidiasis* a major roundworm infection of man. D.I. Grove, ed. (London: Taylor and Francis), – P. 199–231.
63. Grove D.I., Heenan P. J., Northern C. (1983). Persistent and disseminated infections with *Strongyloides stercoralis* in immunosuppressed dogs. Int. J. Parasitol., 13, – P. 483–490.
64. Grove D. I., Warton A., Northern L. L. Yu, C., J. Papadimitriou M. (1987). Light and electron microscopical studies of the location of *Strongyloides stercoralis* in the jejunum of the dog. Int. J. Parasitol., 17, – P. 1257–1265.
65. Gufrij *D. F.,* Gunchak V. M., Kanyuka O. I., Kocyumbas I. YA., Skorohid V. J. (2003). *Dovidnik suchasnih likarskih preparativ dlya praktiki veterinarnoyi medicini (formi vipusku, dozuvannya) [Document of current medicinal preparations for the practice of veterinary medicine (dispensing form, dosing)]. – Lviv, – 240 p. (in Ukrainian).*
66. Gugosyan, Y. A., Boyko, O. O., & Brygadyrenko, V. V. (2019). Morphological variation of four species of Strongyloides (Nematoda, Rhabditida) parasitising various mammal species. Biosystems Diversity, 27(1), 85–98. https://doi.org/10.15421/011913
67. Guzenok M. A. (1983). K jekzogennomu razvitiyu strongiloidov [To the exogenous development of strongyloides]. – Minsk, – P. 34–39.

68. Guzenok M. A. (1986). Rol tehnologicheskih faktorov v jepizootologii strongiloidoza [The role of technological factors in the epizootology of strongyloidiasis]. Abstracts of the report of the 9th Congress of the VOG. – Tbilisi, – P. 45.
69. Halliwel B. (2001). Vitamin C and genomic stability. Mutant. Res. Fund. and Mol. Mech. of Mutagen, 475, – P. 29–35
70. Harvey S. C., Gemmill A. W., Read A. F., Viney M. E. (2000). The control of morph development in the parasitic nematode *Strongyloides ratti*. Proc. R. Soc. Lond., B, Biol. Sci., 267, – P. 2057–2063.
71. Harvey S. C., Viney M. E. (2001). Sex determination in the parasitic nematode *Strongyloides ratti*. Genetics, 158, – P. 1527–1533.
72. Hira P. R., B. G. (1980). Patel Human strongyloidiasis due to the primate species *Strongyloides fuelleborni*. Trop. Geogr. Med., 32, – P. 23–29.
73. Igra-Siegman Y., Sen R. P., Kaminski Z. C., Louria D. B. (1981). Syndrome of hyperinfection with *Strongyloides stercoralis*. Infect. Dis., 3, – P. 397–407.
74. Jiang Jinshu, Chen Gang, Hah Qian (1989). Immunological studies on *Strongyloides papillosus* infection. Acta Veter. Zootechn. Cinica, 20 (8), – P. 1407–1408.
75. Kanyuka O. I., Hariv I. I., Gunchak V. M., Gufrij D. F. (2005). Veterinarni preparati: 2500 najmenuvan likarskih preparativ i yih form: vlastivosti, zastosuvannya, vzayemodiya, pokazannya [Veterinary drugs: 2500 names of drugs and their forms: properties, applications, interaction, indications]. – Lviv, 642 p. (in Ukrainian).
76. Kaplan R. M. (2004). Drug resistance in nematodes of veterinare importance: a status report. Trends Parasitologe, 11 (3), – P. 157–160.
77. Kassie F., Parxefall W., Knasmuller S. (2000). Single cell gel electrophoresis assay: a new technique for human biomonitoring studies. Mutat. Res. Rev. in Mutat. Res., 463, – P. 13–31.
78. Kawanabe M., Nojima H., Uchikawa R. (1988). Transmammary transmission of *Strongyloides ratti*. Parasitol. Res., 75, – P. 50–56.
79. Kirsch-Volders M., Sofimi T., Aardema M., Albertini S., Eastmond D. (2000). Report from the in vitro micronucleus Assay Working Group. Mutat. Res. Envir. and Mol. Mutagen, 35, – P. 167–172.
80. Korenaga M., Nawa Y., Mimori T., Tada I. (1983). Effects of preintestinal larval antigenic stimuli on the generation of intestinal immunity in Strongyloides ratti infection in rats. J. Parasitol., 69, – P. 78–82.

81. Korolenko L. S. , Shendryk L. I., Khoroshun R. V., Matsenko O. O. (2001). Antyhelmintni ta imunostymuliuvalni vlastyvosti levamizolu 8 %-ho pry zmishanykh helmintozakh [Anthelmintic and immunostimulating properties of levamisole 8% in mixed helminthiasis]. Veterinary Medicine of Ukraine, 4, – P. 20–21 (in Ukrainian).
82. Kosenko M., Gufrij, D., Yuskiv, I. (1999). Protynematodni antyhelmintni preparaty [Antinematode anthelmintic drugs]. Veterinary medicine of Ukraine, 2, – P. 14–16 (in Ukrainian).
83. Kravtsiv R. Y., Romanyshyn V. P., Kravtsiv Yu. R. (2001). Veterynarna hematolohiia [Veterinary hematology]. – Lviv, TesRus, – 328 **p.** (in Ukrainian).
84. Kuzhyr T. D. (1999). Antymutaheni y khymycheskyi mutahenez v systemakh visshykh eukaryot [Antimutagens and chemical mutagenesis in the systems of higher eukaryotes]. – Mn.: Technology, – 267 **p.**
85. Kuzmina T. A. (2006). Do epizootolohii stronhilidoziv konei v Ukraini [Epizootology of strongyloidosis of horses in Ukraine]. Veterinary Medicine of Ukraine, 2, – P. 10–12 (in Ukrainian).
86. Kuchyn A. S., Buzmakova R. A. (1974). Klynyko-patoloho-morfolohycheskaia kharakterystyka pnevmonyy pry stronhyloydoze yahniat [Clinical, pathological and morphological characteristics of pneumonia in strongyloidosis of lambs]. Proceedings of the Belarusian NIVI. – Minsk, T. 12, – P. 127–130.
87. Kuchyn A. S., Buzmakova R. A. (1977). Kliniko-morfologicheskie osobennosti strongiloidoza u yagnyat, zarazhennikh v pervie chasi zhizni [Clinical and morphological features of strongyloidiasis in lambs infected in the first hours of life Achievements of vet. science and excellence animal husbandry]. – Minsk, 3, – P. 83–85.
88. Lentze T., Hofer D., Gottstein B., Gaillard C., Busato A. (1999). Prevalence and importance of endoparasites in calves raised in Swiss cow-calf farms. Dtsch. Tierarztl Wochenschr, 106 (7), – P. 275–281.
89. Li X., Massey H. C., Nolan T. J., Schad G. A., Kraus K., Sundaram M., Lok J. B. (2006). Successful transgenesis of the parasitic nematode *Strongyloides stercoralis* requires endogenous non-coding control elements. Int. J. Parasitol., 36, – P. 671–679.
90. Lim S., Katz K., Fuksa S., Keystone J. S., Kain K. C. (2004). Complicated and fatal *Strongyloides* infection in Canadians: risk factors, diagnosis and management. CMAJ, 171, – 479–484.

91. Lysenko A. Ya., Vladimova, M. G., Kondrashin A. V., Maiori Dzh. (2002). Klinicheskaya parazitologiya. Rukovodstvo [Clinical parasitology. Leadership]. – Geneva, WHO, – 752 p.
92. Little M. D. (1966). Comparative morphology of six species of Strongyloides (Nematoda) and redefinition of the genus. J. Parasitol., 52, – P. 69–84.
93. Lovelius N. V., Gritsan Yu. I. (1998). Gidrometeorologicheskie usloviya stepnoi zoni Ukraini [Hydrometeorological conditions of the steppe zone of Ukraine]. Current issues of preservation and restoration of steppe ecosystems: Mater. international of science conf. adj. On the 100th anniversary of the legacy of the Askanian steppe: theses addendum. – Askania-Nova, – P. 197–199.
94. Lu, C.D., Gangyi, X., Kawasc, J.R., 2010. Organic goat production, processing and marketing: Opportunities, challenges and outlook. Small Ruminant Res., 89, – P. 102–109.
95. Lukshina R. G., Fedorov E. I. (2001). Gelmintozoonozi kak problema dlya Ukraini v sovremennikh usloviyakh [Helminthozoonoses as a problem for Ukraine in modern conditions]. Problems of zooengineering and veterinary medicine: Collection. of science of works (Veterinary Sciences). – Kharkiv, 7(31), – P. 40–41.
96. Lukshina R. G., Lokteva I. M., Pavlikovskaya T. N.(2005). Parazitarnie bolezni cheloveka: monografiya [Parasitic human diseases: monograph]. – Kharkiv: Publishing house "INZHEK", – P. 366–381 (in Ukrainian).
97. Lyashenko E. V., Shendryk Ch. M., Soroka N. M. Patent Ukraïni na korisnu model № 69062 "Sposib pidrakhunku yaets gelmintiv u fekaliyakh" [Patent of Ukraine for utility model No. 69062 "Method of counting helminth eggs in feces"]. – declared on 26.07.2011; published 25.04.2012 (in Ukrainian).
98. Lyons E. T., Drudge J. H., Tolliver S. C. (1970). Strongyloides larvae in milk of sheep and cattle. Med. Vet. Pract., 51 (5), – P. 65–68.
99. Lyons E. T. (1994). Vertical transmission of nematodes: Emphasis on Uncinaria lucasi in northern fur seals and *Strongyloides westeri* in equids. J. Helmin. Soc. Wash., 61, – P. 169–178.
100. Malyk O. H., Patereha I. P., Lun M. I. (2001). Fitopreparaty u veterynarnii medytsyni Ukrainy [Phytopreparations in veterinary medicine of Ukraine]. Veterinary medicine of Ukraine, 2, – 30 p (in Ukrainian).

101. Mazurkevich A. Y., Soroka N. M., Zhurenko O. V. (2004). Strukturni zminy u velykoi rohatoi khudoby za spontannoho zarazhennia setariozom [Structural changes in cattle during spontaneous infection with setariasis]. Nauk. Visnik. NAU. – Kyiv, 78, – P. 121–125 (in Ukrainian).
102. Melnyk H. (2006). Vlyianye polyparazytyzma y kompleksnoi protyvoparazytarnoi terapyy na morfolohycheskyi status krupnoho rohatoho skota [Influence of polyparasitism and complex antiparasitic therapy on the morphological status of cattle]. Thesis is presented for conferring a scientifc degree of Doctor of Biology Sciences on a speciality 03.00.19 – Parasitology, helminthology. Chisinau, – 150 p.
103. Mykhailivskyi M. M. (1989). Khid invazii Strongyloides papillosus i nematod rodyny Trichostrongylidae u ovets [Course of infestation of Strongyloides papillosus and nematodes of the Trichostrongylidae family in sheep]. Abstracts of add. science and theory conf. young scientists and graduate students. – Kamianets-Podilskyi, – P. 73–74 (in Ukrainian).
104. Mitreva M., McCarter J. P., Martin J., Dante M., Wylie T., Chiapelli B., Pape D., Clifton S. W., Nutman T. B., Waterson R. H. (2004). Comparative genomics of gene expression in the parasitic and free-living nematodes *Strongyloides stercoralis* and *Caenorhabditis elegans*. Genome Res, 14, – P. 209–220.
105. Moncol D. J., Grice M. J. (1974). Transmammary passage of *Strongyloides papillosus* in the goat and sheep. Proc. Helmin. Soc. Wash., 41, – P. 1–4.
106. Moncol D. J., Triantaphyllou A. C. (1978). *Strongyloides ransomi*: Factors influencing the in vitro development of the free-living generation. J. Parasitol., 64, – P. 220–225.
107. Nakamura Y., Ooba C. , Hirose H. (1998). Recovery from arrhythmias in lambs infected with *Strongyloides papillosus* following worm elimination. J. Helminthol., 72 (1), – P. 43–46.
108. Yazwinski T. A. , Featherston H. E., Johnson Z. B., Brown A. H. (1992). New developments for internal parasite control in beef cattle. Agr. Experiment Station Division Agr. Univ. Arkansas: Special Report. Univ Arkansas. – Fayetteville, – P. 11–14.
109. Nolan T. J., Katz F. F. (1981). Transmammary transmission of *Strongyloides venezuelensis* (Nematoda) in rats. Proc. Helmin. Soc. Wash., 48 (8), – P. 12.

110. Nechyporenko V. Kh. (1975). Spontanni strukturni zminy khromosom v klitynakh kistkovoho mozku svynei riznykh porid [Spontaneous structural changes of chromosomes in the bone marrow cells of pigs of different breeds Pig breeding], – 22. – P. 82–85.
111. Novikova T.V. (1995). Kishechnie invazii u telyat pri raznikh sposobakh ikh soderzhaniya v Volgogradskoi oblasti [Intestinal invasions in calves with different ways of keeping them in the Volgograd region]. Mater. IV Congress of Parasitocenologists of Ukraine. – Kharkiv, – P. 34–35 (in Ukrainian).
112. Nwaorgu O. C. (1983). The development of the free-living stages of *Strongyloides papillosus*. I. Effect of temperature on the development of the het-erogonic and homogonic nematodes in faecal culture. Vet. Parasitol., 13(3), – P. 213–223.
113. Nwaorgu O. C., Onyali I. O. (1990). *Strongyloides papillosus*: prenatal and transmammary infection in ewes. Rev. Elev. et Med. Vet. Pays Trop., 43 (4), – P. 503–504.
114. Onyali I. O., Onwuliri C. O., Ajayi J. A. (1989). *Strongyloides papillosus* infectations of lambs in Plateau State of Nigeria. Rev. Elevage Med. Vet., 42 (2), – P. 223–226.
115. Osting O., Johanson K. J. (1984). Microelectrophoretic study of radiation-induced DNA damages in individual mammalian cells. Biochem. Biophys. Res. Commun., 123, – P. 291–298.
116. Parkinson J. A., Mitreva M., Whitton C., Thompson M., Daub J., Martin J., Schmid R., Hall N., Waterson R. H., McCarter J. P., Blaxter M. L. (2004). Transcriptomic analysis of the phylum *Nematoda*. Nat. Genet., 36, – P. 1259–1267.
117. Pavlasek I., Nikitin V. F. (1991). Metodika izolace cistych kultur invaznach larev strevnichhlistic rodu *Strongyloides* a podradu *Strongylata*. Vet. Med., 36 (6), – P. 381–383.
118. Pavlikovska T. M., Nekrasova A. S., Svita V. M. (1994). Situatsiya iz parazitarnikh khvorob v Ukraïni ta shlyakhi ïï polipshennya [The situation with parasitic diseases in Ukraine and ways to improve it]. Materials of the 3rd Congress of Parasitocoenologists. – Kyiv, – P. 5–6.
119. Pobyarzhin V. V, Bekish V. Ya. (2003). Narusheniya v genome khozyaina pri eksperimentalnom gimenolepidoze v zavisimosti ot dozi vvedennogo invazionnogo materiala pri zarazhenii [Disturbances in the host genome in experimental hymenolepiasis depending on the

dose of the introduced invasive material during infection]. Vestnik VSMU, 2 (4), – P. 84–89.
120. Pobyarzhin V. V. (2000). Vzaimosvyaz mezhdu dozoi zarazheniya invazionnim materialom i pokazatelyami mikroyadernogo testa v kletkakh kostnogo mozga mishei pri gimenolepidoze. Tkan. gelmintozi: diagnostika, patogenez, klinika, lechenie i epidemiologiya [The relationship between the dose of infection with invasive material and the parameters of the micronucleus test in bone marrow cells of mice with hymenolepiasis. Fabric. helminthiases: diagnosis, pathogenesis, clinic, treatment and epidemiology]. Works of scientific and practical. conf. – Vitebsk, – P. 72–76.
121. Pogorelchuk T. Ya. (2008). Zakhodi z profilaktiki strongiloïdozu sered naselennya Odeskoï oblasti [Measures to prevent strongyloidiasis among the population of Odesa region]. Modern infections, 2, – P. 39–43. (in Ukrainian).
122. Pozhivil A., Gorzheev V. (2002). Kontseptsiya borotbi z gelmintozami tvarin [The concept of combating animal helminthiasis]. Veterinary medicine of Ukraine, 4, – P. 20–21 (in Ukrainian).
123. Ponomar S. I. (2001). Rekomendatsiï shchodo zastosuvannya kameri dlya pidrakhunku yaets gelmintiv [Recommendations for using a camera for counting helminth eggs]. Bila Tserkva, – 12 p. (in Ukrainian).
124. Ponomar S. I. (2002). Problema strongiloïdozu svinei v Ukraïni [The problem of strongyloidosis of pigs in Ukraine]. Bulletin of the Bilotserki State Agrarian University: Collection of Scientific Works. – White Church, 23, – P. 146–150.
125. Ponomar S. I., Antipov A. A., Soroka N. M. Otsinka epizootychnoi sytuatsii zi stronhiloidoznoi invazii v hospodarstvakh z vyrobnytstva svynyny [Assessment of the epizootic situation of strongyloidosis infestation in pork farms]. Mater. of the third international science-practice conference: "Development of scientific research 2007". – Poltava: Intergrafika, – P. 56–58 (in Ukrainian).
126. Ponomar S. I., Artemenko L. P., Lytvynenko O. P., Honcharenko V. P. (2011). Dovidnyk z laboratornykh metodiv diahnostyky invaziinykh khvorob [Handbook of laboratory methods for the diagnosis of invasive diseases]. – Bila Tserkva; BCNAU, – 152 p. (in Ukrainian).
127. Ponomar S. I., Soroka N. M., Lytvynenko O. P. (2010). Rekomendatsii z laboratornoi diahnostyky shlunkovo-kyshkovykh helmintoziv

tvaryn [Recommendations for laboratory diagnosis of gastrointestinal helminthiasis in animals]. – Bila Tserkva, – 68 p. (in Ukrainian).
128. Ponomarenko V. Ya. Kulshyn V. Ye., Bulavina V. S. (2009). Identyfikatsiia Giardia intestinalis u populiatsii bezprytulnykh sobak za dopomohoiu IFA ta PLR [Identification of Giardia intestinalis in a stray dog population by ELISA and PCR]. Problems of zooengineering and veterinary medicine: a collection of scientific works of the KhDZVA, 19 (44), – P. 378–384. (in Ukrainian).
129. Pryima O. B., Stybel V. V., Danko M. M., Svarchevskyi O. A., Loboiko Yu. V. (2012). Metodychni rekomendatsii z diahnostyky, likuvannia ta profilaktyky toksokarozu sobak [Methodological recommendations for diagnosis, treatment and prevention of toxocariasis in dogs]. – Lviv, – 28 p (in Ukrainian).
130. Prichard R. K. (1990). Anthelmintic resistance in nematodes extent, resent understanding and future directions for cjntrol and research. Parasitology, 20. (4), – P. 515–521.
131. Prykhodko Yu. O. (2012). Miulerioz kiz: epizootolohiia, diahnostyka i likuvannia [Mulleriosis of goats: epizootology, diagnosis and treatment]. Veterinary medicine of Ukraine, 1 (191), – P. 13–17 (in Ukrainian).
132. Rebollo C. D., Taira N., Ura S., Williams J. C. (2003). Larvicidal effects of several chemicals on *Strongyloides* infective larvae. Vet. Parasitol., 118(1–2), – P. 165–168.
133. Riskin E. V. (1973). Klinicheskaya kartina strongiloidoza krolikov i ovets [Clinical picture of strongyloidiasis in rabbits and sheep]. Proceedings of the Kazan Veterinary Institute, 25, – P. 231–235.
134. Salem S. A., el-Kowrany S. I., Ismail H. I., el-Sheikh T. F. (2001). Study on the possible role of heat shock proteins in host resistance to *Trichinella spiralis* infection in experimental animals. J. Egypt. Soc. Parasitol., 31 (l), – P. 133–144.
135. Schmid W. (1975). The micronucleus test. Mutat. Res., 31 (1). – P. 9–16.
136. Sekretariuk K.,V., Stybel V.V., Svarchevskyy O.A., Tafiichuk P.I. (2001). Parazytotsenoz ta yoho henetychni aspekty [Parasitocenosis and its genetic aspects]. Problems of zooengineering and veterinary medicine. 3b. scientific works. Veterinary sciences. Mater. of the 5th Congress of Parasitocenologists of Ukraine (April 5-6, 2001), 7 (31), – P. 61–62 (in Ukrainian).

137. Sekretariuk K.,V., Svarchevskyy O.A., Tafiichuk P.I. (2005). Helmintolohichni doslidzhennia tvaryn i navkolyshnoho seredovyshcha u veterynarnii medytsyni [Helminthological studies of animals and the environment in veterinary medicine]. – Lviv: Spolom, – 110 p. (in Ukrainian).
138. Sekretariuk K.,V., Svarchevskyy O.A. (2007). Osnovy ekolohichnoi zooparazytolohii [Basics of ecological zooparasitology Scientific edition]. – Lviv, – 360 p. (in Ukrainian).
139. Shablovskaya Ye. A., Smaga M. F. (1962). Epizootologicheskoe obsledovanie ochaga strongiloidoza vo Lvovskoi psikhonevrologicheskoi bolnitse [Epizootological examination of the focus of strongyloidiasis in the Lviv psycho-neurological hospital]. Abstracts of the reports of the scientific conference VOG, 2. – P. 143.
140. Shakirov A. B. (2004). Gelminti i gelmintozi krupnogo rogatogo skota v Kirgizskoi respublike i meri borbi s nim [Helminths and helminthiases of cattle in the Kyrgyz Republic and measures to combat it]. Thesis is presented for conferring a scientifc degree of Doctor of Veterinary Sciences on a speciality 03.00.19 – Parasitology, Bishkek.– P. 275.
141. Shevchenko A. M. (2006). Paramfistomatydozy zhuinykh tvaryn (epizootolohiia, diahnostyka, likuvannia i profilaktyka) [Paramphistomatosis of ruminants (epizootology, diagnosis, treatment and prevention)]: avtoreferat thesis is presented for conferring a scientifc degree of candidate of veterinary sciences on a speciality 16.00.11 – parasitology. – 18 p.
142. Shendryk Ch. M. (2010). Terapevtychna efektyvnist "Helmindazolefektu" za stronhiloidozu teliat [Therapeutic effectiveness of "Helmindazole-effect" for strongyloidiasis in calves]. Scientific bulletin of NUBiPU, 161 (1), – P. 125–128.
143. Shendryk Ch. M., Shendryk I. M. (2012). Patomorfolohichni zminy za eksperymentalnoho stronhiloidozu [Pathomorphological changes in experimental strongyloidosis]. Scientific and technical collection. Bulletin of ZhNAEU. – Zhytomyr, 2 (32), – P. 108–110.
144. Shendryk L. I., Boyko O. O., Shendryk Ch. M. (2021). Common helminthiasis of productive animals of Ukraine. Dnipro, Lira, 156 p. doi: 10.15421 / 512105
145. Shepetukha A. M. (2009). Travy – proty parazytiv [Herbs – against parasites Veterinary medicine of Ukraine], 5, – P. 44–45.

146. Shoop W. L., Michael B. F., Eary C. H., Haines H. W. (2002). Transmammary transmission of *Strongyloides stercoralis* in dogs. J. Parasitol., 88, – P. 536–539.
147. Soroka N. M. (2001). Biokhimichni doslidzhennia krovi velykoi rohatoi khudoby, khvoroi na hostryi perebih setariozu [Biochemical studies of the blood of cattle suffering from acute setariasis]. Scientific Bulletin of the Lviv State Academy of Veterinary Medicine named after S.Z. Gzytsky. – Lviv, 3. (2), – P. 149–152 (in Ukrainian).
148. Soroka N.M. Etiolohichni i patohenetychni faktory u vynyknenni ta rozvytku setariozu velykoi rohatoi khudoby [Etiological and pathogenetic factors in the occurrence and development of setariasis in cattle].)]: avtoreferat thesis is presented for conferring a scientifc degree of doctor of veterinary sciences on a speciality 03.00.19 – parasitology. Kyiv, – 34 p. (in Ukrainian).
149. Soroka N. M., Shendryk Ch. M. (2011). Rekomendatsii z diahnostyky, terapii ta profilaktyky stronhiloidozu zhuinykh [Recommendations for diagnosis, therapy and prevention of strongyloidiasis in ruminants]. – Kyiv: Vetinform, – 20 p. (in Ukrainian).
150. Speare R. (1989). Identification of species of *Strongyloides*. In *Strongyloidiasis* a major roundworm infection of man. D. I. Grove, ed. (London: Taylor and Francis), – P. 11–84.
151. Stepanov A. V. (1992). Mikroyadernii test pri eksperimentalnom trikhotsefaleze [Micronuclear test in experimental trichuriasis]. Collection of scientific papers: The role of hereditary factors in the pathogenesis of human diseases. – Vitebsk, – P. 79–84.
152. Stybel V. V. (1999). Metodichni vkazivki z tsitogenetichnogo analizu i rezultati doslidzhen. Zmini u khromosomnomu aparati somatichnikh klitin pri askaridozi porosyat [Methodological guidelines for cytogenetic analysis and research results. Changes in the chromosomal apparatus of somatic cells in piglet ascariasis]. – Lviv, – 8 p. (in Ukrainian).
153. Stybel V. V. (2004). Izmeneniya v nasledstvennom apparate svinei pri askaridoznoi invazii [Changes in the hereditary apparatus of pigs with ascariasis invasion]. Proceedings of the 4th International Scientific and Practical Conference. – Vitebsk, – P. 73–75.
154. Stybel V. V. (2005). Potentsiina mutahenna diia eksperymentalnykh likarskykh form brovermektyn poroshok i brovermektyn-hranuliat [Potential mutagenic effect of experimental dosage forms of brover-

mectin powder and brovermectin granules]. Visnyk DDAU. – Dnipropetrovsk, 2, – P. 46–51.
155. Stybel V. V. (2006). Mutahenna diia metabolitiv nematod na henom khaziaina [Mutagenic effect of nematode metabolites on the host's genome Scientific]. Bulletin of NAU. – Kyiv, 98. – P. 197–201. (in Ukrainian).
156. Stybel V. V. (2006). Metaboliti nematod kak mutageni somaticheskikh kletok khozyaina [Metabolites of nematodes as mutagens of somatic cells of the host]. Trudy V Republican Scientific-Pract. conf. – Vitebsk, – P. 421–425.
157. Stone W. M., Smith F. W. (1973). Infection of mammalian hosts by milk-borne nematode larvae: a review. Exp. Parasitol., 34,– P. 306–312.
158. Taura N., Nakamura Y., Tsuji N., Kubo M., Ura S. (1992). Sudden death of calves by experimental infection with *Strongyloides papillosus*. I. Parasitological observations. Vet. Parasitol., 42 (3–4), – P. 247–256.
159. Tassi P., Barth D., Gross S. J. (1990). The efficacy of ivermectin against *Strongyloides papillosus* in cattle. Parassitologia., 32 (3), – P. 347–352.
160. Tekhnichni umovy Ukrainy na preparat helmindazol-efekt TU U 24.4.00493675-001-2010 u DNDKI vetpreparativ ta kormovykh dobavok [Technical conditions of Ukraine for the drug helmindazole-effect TU U 24.4.00493675-001-2010 in the DNDKI of veterinary drugs and feed additives] (in Ukrainian).
161. Thompson F. J., Mitreva M., Barker G. L. A., Martin J., Waterston R. H., McCarter J. P., Viney M. E. (2005). An expressed sequence tag analysis of the life-cycle of the parasitic nematode *Strongyloides ratti*. Mol. Biochem. Parasitol., 142, – P. 32–46.
162. Thompson F. J., Barker G. L. A., Hughes L., Wilkes C. P., Coghill J., Viney M. E. (2006). A microarray analysis of gene expression in the free-living stages of the parasitic nematode Strongyloides ratti / F. J. Thompson, // BMC Genomics, 7, – P. 157–177.
163. Tindall N. R., Wilson P. A. G. (1988). Criteria for a proof of migration routes of immature parasites inside hosts exemplified by studies of *Strongyloides ratti* in the rat. Parasitology, 96, – P. 551–563.
164. Trach V. N. (1992). Rekomendatsii po primeneniyu novogo metoda ucheta yaits gelmintov i tsist prosteishikh v fekaliyakh zhivotnikh [Recommendations for the application of a new method for counting helminth eggs and protozoan cysts in animal feces]. –Kyiv, – 16 p. (in Ukrainian).

165. Triantaphyllou A. C., Moncol D. J. (1977). Cytology, reproduction, and sex determination of *Strongyloides ransomi* and *S. papillosus*. J. Parasitol., 63, – P. 961–973.
166. Turner S. A., Maclean J. D., Fleckenstein L., Greenaway C. (2005). Parenteral administration of ivermectin in a patient with disseminated strongyloidiasis. Am. J. Trop. Med. Hyg., 73, – P. 911–914.
167. Usenko-Shendryk Ch. M. (2008). Riven stronhiloidoznoi invazii khudoby na Dnipropetrovshchyni v zalezhnosti vid umov utrymannia [The level of strongyloidiasis infestation of livestock in Dnipropetrovsk Oblast depending on the conditions of keeping]. Scientific and technical bulletin of the Institute of Animal Biology and DNDKI of Veterinary Medicines and Feed Additives, 9 (4), – P. 272–275.
168. Usenko-Shendryk Ch. M. (2009). Osoblyvosti epizootolohii stronhiloidozu khudoby v tsentralnii chastyni Ukrainy [Peculiarities of the epizootology of strongyloidosis of cattle in the central part of Ukraine]. Scientific bulletin of LNUVMBT named after S.Z. Gzhitskyi. – Lviv, T. 11, 2 (41), – P. 326–328.
169. Usenko-Shendryk Ch. M. (2010). Zminy pokaznykiv krovi u teliat, urazhenykh stronhiloidozom [Changes in blood parameters in calves affected by strongyloidosis]. Scientific Bulletin of NUBiPU, 151 (2), – P. 199–202.
170. Usenko-Shendryk Ch. M. (2009). Osoblyvosti perebihu stronhiloidozu u teliat [Peculiarities of the course of strongyloidosis in calves]. Theses add. XIV International Conference of the Ukrainian Scientific Society of Parasitologists (Uzhhorod, September 21–24, 2009) – Kyiv, – P. 112.
171. Vergors H. H. (1975). Experimental infection of calves with *Strongyloides papillosus*. J. Amer. Vet. Med. Ass., 19(3.1), – P. 721–725.
172. Veselij V. A. Poshirennya osnovnih gelmintoziv zhujnih tvarin ta rozrobka zasobiv borotbi iz zastosuvannyam albendazolu [Prevalence of major ruminant helminthiasis and development of albendazole control agents]: avtoreferat thesis is presented for conferring a scientifc degree of candidate of Veterinary Sciences on a speciality 16.00.11. – Parasitology, Helminthology. – Kharkiv, – 2008. – 24 p. (in Ukrainian).
173. Vislobokov V. A. Strongiloidoz loshadej v centralnom rajone Nechernozemnoj zony Rossijskoj Federacii: biologiya vozbuditelya, jepizootologiya, patogenez, lechenie i profilaktika [Strongyloidiasis in horses in the central region of the Non-Chernozem zone of the Russian Fed-

eration: pathogen biology, epizootology, pathogenesis, treatment and prevention]: avtoreferat thesis is presented for conferring a scientifc degree of candidate of medical sciences on a speciality 03.00.19 – Cryobiology. – Ivanovo, – 2009. – 150 p. (in Ukrainian).
174. Viney M. E. (1994). A genetic analysis of reproduction in *Strongyloides ratti*. Parasitology, 109, – P. 511–515.
175. Viney M. E., Thompson F. J., Crook M. (2005). TGF-β and the evolution of nematode parasitism. Int. J. Parasitol., 35, – P. 1473–1475.
176. Viney M. E., Steer M. D., Wilkes C. P (2006). The reversibility of constraints on size and fecundity in the parasitic nematode *Strongyloides ratti*. Parasitology, 133, – P. 477–483.
177. Waghmare S. P., Rode A. M., Sapre V. A., Sarode D. B. (1991). Anthegelmintic efficacyofivermectin and albendazole against gastrointeral helminth infection in buffalo calves. Ind. J. Veter. Med., 11 (1–2), – P. 70–71.
178. Waller P. J. (1997). Anthelmintic resistance. Veter. Parasitology, 72, – P. 391–412.
179. Wilkes C. P., Thompson F. J., Gardner M. P., Paterson S., Viney M. E. (2004). The effect of the host immune response on the parasitic nematode *Strongyloides ratti*. Parasitology, 128, – P. 661–669.
180. Yamada M., Matsuda S., Nakazawa M., Arizono N. (1991). Species-specific differences in heterogonic development of serially transferred free-living generations of *Strongyloides planiceps* and *Strongyloides stercoralis*. J. Parasitol., 77, – P. 592–594.
181. Ziomko I. (1986). Wlastiwosti biologiczne nicienia *Strongyloides papillosus* oraz patogeneza wengorczycy oviec. Pulawy, – P. 57.
182. Ziomko I., Yvore P. (1996). .Effect of incubation conditions of *Strongyloides papillosus* eggs on the development of infective larvae and free-living males and females. Bull. Vet. Inst. Pulawy, 40 (l), – P. 25–29.
183. Zonalnoe rasprostranenye helmyntov y hlavneishykh helmyntozov selskokhoziaistvennыkh zhyvotnыkh v Azerbaidzhane y predlozhenyia po usylenyiu borbы s nymy [Zonal distribution of helminths and the main helminthiases of farm animals in Azerbaijan and proposals for strengthening the fight against them] / [ed. S. M. Asadov] – Baku: ELM. – 1975. – 90 p.
184. Zon H. A. (2005). Patolohichna anatomiia parazytarnykh khvorob tvaryn [Pathological anatomy of parasitic diseases of animals]. – Sumy, Zherelo, – 226 p. (in Ukrainian).

185. Yakubovskii M. V. Effektivnost novikh otechestvennikh preparatov pri parazitarnikh boleznyakh zhivotnikh [The effectiveness of new domestic drugs in parasitic diseases of animals]. Proceedings of the international scientific-practical conference "Actual problems of veterinary medicine in the conditions of modern animal husbandry", dedicated to the 75th anniversary of the Institute of Experimental Veterinary Medicine. Vyshelessky National Academy of Sciences of Belarus and the 100th anniversary of the birth of Academician R. S. Chebotarev. – Minsk. – 2005. – Вып. 38. – С. 564–570.
186. Yatusevich A.I. (2000). Biologicheskie osobennosti vozbuditelya i meri borbi so strongiloidozom [Biological features of the pathogen and measures to combat strongyloidiasis]. Proceedings of the scientific and practical conference. – Vitebsk, – P. 50–52.
187. Yevstafyeva V. O. Asociativni invaziyi svinej v umovah Lisostepu i Stepu Ukrayini [Associative invasions of pigs in the Forest-Steppe and Steppe of Ukraine]: avtoreferat thesis is presented for conferring a scientifc degree of Doctor of Veterinary Sciences on a speciality 16.00.11 – Parasitology. –2010. – 34 p. (in Ukrainian).
188. Yevtushenko A. F., Radionov M. T. (2004). Organizaciya ta ekonomika veterinarnoyi spravi [Organization and economics of veterinary affairs]. – Kyiv, Aristei, – 244 p.

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