ESTABLISHING OF THE MONO- AND POLYINVASION IMPACT ON SOME MORPHO-FUNCTIONAL INDICES IN WILD BOARS

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Abstract. In the paper is described the mono- and poly-invasions impact on some morpho-functional indices in wild boars. So, in result of the investigation of hematological indices in uninfested mono- and poly-parasitized wild boars, it was established that both the indices of hemoglobin content, of hematocrit, erythrocyte's number, thrombosis time and ESR (erythrocyte sedimentation rate) vary and are more increased in the I group with uninfested wild boars compared to mono - and poly-parasitized ones. It has been established that at infested boars with *S. papillosus* from the I group, and in those infested with *D. lanceolatum* from the II group there is a decrease of hemostatic indices, but their maximum decrease is highlighted in the IV group with wild boars infested with *Dicrocoelium lanceolatum*, *Strongyloides papillosus*, *Metastrongylus elongatus* and *Eimeria deblicieki*. This decrease is due to eliminated exotoxins by parasites, which contain anticoagulants and hemolyzers and which neutralize the fibrinogen, thrombin, Ca⁺ ions and vitamin K properties from the body.

Introduction

According to data from the bibliographic references the parasitic agents can directly influence the host's biochemical reactions, which represent practical and theoretical interest, because they determine the consequences of their interaction with the host, they disrupt metabolism, increasing the blood serum ferments activity, it's changing the proteinogram, immunogram, plasma hemostasis indices [1-4, 9-12, 20-22].

The evaluation of the disease, caused by the pathogenic action of the larvae in the migration phase, predominates the cellular defense factor. The hemostasis indices show about the organism's protective reaction that happens in stopping the hemorrhages. An optimal physiological blood clotting function maintaining is essential. The blood clotting deficiencies have a major impact on its intravascular fluidity. Excessive coagulation can lead to a blood vessel occlusion of vital importance, and the deficient one can cause a hemorrhagic condition, very difficult to fight [5-8, 13- 19].

Also, it is known that in order to be developed effective measures in stabilizing hemostasis indices it is necessary to study their disorders level in mono- and polyparasite infestations and after that, can be taken measures for their normalization [5-8].

Materials and methods

The parasitological researches were carried out in the laboratory of Parasitology and Helminthology of the Institute of Zoology on 82 biological samples, collected during 2019 year from wild boars, raised at hunting from the "Pădurea Domneasă" Nature Reserve forest ecosystem.

In the order to achieve the proposed objectives, were used coproovoscopic methods (*Fulleborn, Darling*), coprolarvoscopic methods (*Popov, Baermann*) and successive washing meth-

od. The invasion's intensity with nematodes was established in 5 g of fetuses, and the oocysts of *Eimeria* spp., eggs of *Fasciola hepatica*, *Dicrocoelium lanceolatum*, etc., in 10 visual microscopic fields (10x40).

The mono- and polyinvasions impact on some morpho-functional indices in wild boars was identified by determining hematological indices, proteinogram indices and by plasma hemostasis indices in the reference laboratories.

Results and discussion

A special section of the investigations was to establish the impact of parasitic agents on the host - body to wild boars, through the analysis prism of hematological and biochemical indices. The collection of blood samples in order to establish some hematological and biochemical indices, have been taken from wild boars with different levels of infestation from various natural and anthropogenic biotopes of the Republic of Moldova.

The main objective of the investigations was to evaluate the consequences of mono- and polyparasitosis on the physiological status of wild boars. In order to achieve this objective, was initially studied the parasitofauna in wild boars, after which were selected 20 specimens and distributed in 4 groups with 5 wild boars in each lot: the I group - uninfested, the II group - spontaneously infested with *Strongyloides papillosus*, the III group - spontaneously infested with *Dicrocoelium lanceolatum* and the IV group - spontaneously polyinfested with *Dicrocoelium lanceolatum*, *Strongyloides papillosus*, *Metastrongylus elongatus* și *Eimeria debliciecki*.

Determination of hematological indices (hemoglobin, erythrocytes, leukocytes, hematocrit, prothrombin, thrombosis time, erythrocyte sedimentation rate (ESR)) was performed at uninfested, mono- and polyparasitized wild boars (tab. 1).

Table 1. Mono- and polyinvasions impact on hematological indices in wild boars

Groups	Hb (g/100ml sânge)	Erythrocytes, 10 ⁶ mm ³	Leukocytes, thousand / mm ³	Hematocrit (%)	Prothrombin %	Throm- bosis time (sec.)	ESR (ml/sec)
I	13,0±1,5	7,2±0,6	11,2±1,2	41,5±3,6	86,7±4,2	42,2±2,3	0,8±0,14
II	8,0±0,4	5,5±0,4	13,8±1,6	32,2±3,2	85,3±3,5	36,6±1,8	0,5±0,12
III	9,0±0,7	6,5±0,7	13,5±1,4	35,5±2,5	85,7±3,6	34,5±1,3	0,6±0,11
IV	7,4±0,5	4,2±0,3	14,4±2,5	28,6±2,0	84,2±3,3	32,4±1,1	0,5±0,10

In the result of the hematological indices investigation in mono- and polyparasitic uninfested wild boars, it was established that both the hemoglobin content indices, hematocrit, erythrocytes number, thrombosis time and ESR (erythrocyte sedimentation rate) vary and are higher at the I group with uninfested wild boars, compared to mono- and polyparasitic ones. The leukocyte content, being opposite, decreased in the I group - uninfested, comparative to its values at the II group - spontaneously infested with *Strongyloides papillosus*, the III group - spontaneously infested with *Dicrocoelium lanceolatum* and the IV group - spontaneously infested with *Dicrocoelium lanceolatum*, *Strongyloides papillosus*, *Metastrongylus elongatus* și

Eimeria deblicieki. Therefore, the index of hemoglobin content is more increased in the I group with uninfested wild boars, by 38,5% ($P > 0,05$), comparative to the II group - spontaneously infested with *Strongyloides papillosus*, by 30,8% ($P > 0,05$) comparative to the III group - spontaneously infested with *Dicrocoelium lanceolatum* and by 43,0% ($P > 0,05$) comparative to the IV group - wild boars spontaneously infested with *Dicrocoelium lanceolatum*, *Strongyloides papillosus*, *Metastrongylus elongatus* și *Eimeria deblicieki*. The erythrocytes number also varies from group to group and being in the I group by 23,6% ($P > 0,05$) higher comparative to the II group, by 9.7% ($P > 0,05$), comparative to the III group and by 41,7% ($P > 0,05$), comparative to the IV group. The values of hematocrit and ESR indices are also higher in the I group by 22,4% ($P > 0,05$), comparative to the II group, by 14,5% ($P > 0,05$), comparative to the III group and by 31,0% ($P > 0,05$), comparative to the IV group for hematocrit content, and respectively higher in the I group by 37,5% ($P > 0,05$), comparative to the II and the IV group, and by 25,0% ($P > 0,05$), comparative to the III group for ESR. Thrombosis time indices, was highlighted higher for the I group of uninfested wild boars by 15,9%, comparative to the II and the III groups with monoparasitized wild boars (*Strongyloides papillosus*, *Dicrocoelium lanceolatum*) and by 23,3% ($P > 0,05$) comparative to the IV group with polyparasitized wild boars (*Dicrocoelium lanceolatum*, *Strongyloides papillosus*, *Metastrongylus elongatus* și *Eimeria deblicieki*).

The leukocyte content shown in wild boar groups was on average lower in the I group, by 17,7% ($P > 0,05$), comparative to the II and the III groups and by 22,3% ($P > 0,05$), comparative with the IV lot. Also, it was studied the impact of monoinvasions (*Strongyloides papillosus*, *Dicrocoelium lanceolatum*) and polyinvasions (*Dicrocoelium lanceolatum*, *Strongyloides papillosus*, *Metastrongylus elongatus* și *Eimeria deblicieki*) on the lymphocyte indices in wild boars (tab. 2).

Table 2. Mono- and polyinvasions impact on leukogram in wild boars

Groups	Leuko- cytes (thousand /mm ³)	Throm- bocytes (mii/ mm ³)	Leukocyte formula (%)						
			Baso- phils	Eosino- phils	Neutrophil			Lym- phocytes	Mono- cytes
					Young	Stick	Seg- mented		
I	11,2±1,2	284±10,4	0,5±00,6	3,2±0,12	1,6±0,4	2,5±0,26	40,6±5,3	47,9±4,2	3,7±0,34
II	13,8±1,6	272±12,0	0,4±00,4	4,5±0,24	2,2±0,7	3,7±0,34	42,4±5,6	41,7±4,4	5,7±0,62
III	13,5±1,4	274±12,3	0,4±00,3	3,9±0,28	2,8±0,6	3,4±0,32	45,8±6,4	38,6±3,7	5,4±0,76
IV	14,4±2,5	265±12,6	0,2±00,2	5,4±0,26	3,7±0,8	4,8±0,38	45,4±5,8	35,5±3,8	6,0±0,74

In the analysis result of the leukocyte formula in wild boars, was found a decrease of the eosinophils number from the I group - uninfested by 29,0% ($P > 0,05$), comparative to the II group - spontaneously infested with *Strongyloides papillosus*, by 18,0% ($P > 0,05$), comparative to the III group - spontaneously infested with *Dicrocoelium lanceolatum* and respectively with 40,8% ($P > 0,05$) decreased, comparative to the IV group, with polyparasitized wild boars (*Dicrocoelium lanceolatum*, *Strongyloides papillosus*, *Metastrongylus elongatus* and *Eimeria deblicieki*). Depending on the parasitic species and the level of wild boar infestation, there are variations in the leukocyte formula of the young neutrophils content, which are also decreased

in the I group - uninfested wild boars by 27,3% ($P > 0,05$), comparative to those from the II group, by 42,9% ($P > 0,05$), comparative to those from the III group and by 56,8% ($P > 0,05$), comparative to the IV group. The lymphocyte indices analysis shows variations in the lymphocyte content, which is higher in the I group with uninfested wild boars by 13,0% ($P > 0,05$), comparative to those from the II group, by 19,5% ($P > 0,05$), comparative to those from the III group and by 25,9% ($P > 0,05$), comparative to polyparasitized wild boars from the IV group.

In the study's result of the impact of mono- and polyinvasions on lymphocyte indices in wild boars, it was possible to highlight the fact that both their invasion with *Strongyloides papillosus* from the II group, and with *Dicrocoelium lanceolatum* from the III group, and polyinvasion with *Dicrocoelium lanceolatum*, *Strongyloides papillosus*, *Metastrong elongatus* and *Eimeria deblickei*, ultimately, leads to the substances release with immunotoxic action on B, T and Th lymphocytes, affecting them morphofunctionally and increasing the amount of null and Ts lymphocytes (tab. 3).

In the study's result of the mono- and polyinvasions impact, on the proteinogram's indices in wild boars, was established in them the content of total proteins, albumins and globulins (tab. 4).

Table 3. Mono- and polyinvasions impact on lymphocyte indices in wild boars

Groups	Total lymphocytes %	Lymphocytes				
		B %	T %	null %	Th %	Ts %
I	47,9±4,2	17,4±2,4	52,0±2,6	22,1±3,2	22,1±1,1	18,3±1,2
II	41,7±4,4	16,2±1,3	28,1±1,7	47,4±3,4	12,0±1,1	27,3±1,4
III	38,6±3,7	12,2±1,5	21,4±1,5	54,2±2,3	9,8±2,2	25,3±2,4
IV	35,5±3,8	10,2±1,5	20,2±1,4	58,3±2,6	10,2±2,4	28,4±3,6

Table 4. Mono- and polyinvasions impact on proteinogram indices in wild boars

Groups	Total protein, g/100ml	Albumins, %	Globulins			
			α_1	α_2	β	γ
			%	%	%	%
I	7,7±1,16	35,4±1,62	8,0±0,34	9,5±0,52	11,9±0,45	27,8±1,45
II	5,1±1,12	30,2±1,12	6,4±0,44	10,4±0,34	13,5±0,82	33,3±0,78
III	6,2±0,99	32,8±0,77	6,9±0,43	11,6±0,37	14,6±0,54	32,2±1,13
IV	4,8±0,86	27,6±0,86	5,4±0,32	12,4±0,34	15,8±0,32	36,4±1,62

In the wild boars from the II group, infested spontaneously with *Strongyloides papillosus*, was observed a total protein's content of 33,8% ($P > 0,05$), in those from the III group - by 19,5% ($P < 0,05$), and in those from the IV group - by 37,7% ($P < 0,05$) decreased, comparative to the I group. The albumin decreases by 14,7% ($P < 0,01$) in the II group, by 7,4% ($P < 0,01$) in the III group and by 22,0% ($P < 0,01$) in the IV group, comparative to the I group, uninfested.

The α_1 globulins, decreased by 20,0% ($P < 0,05$) in the II group, in the III group - by 13,8%, and in the IV group - by 32,5%, comparative to the I group. The globulins α_2 level from the II group was with 8,7% ($P > 0,05$), in the III group with 18,1% ($P > 0,05$), and in the IV group - with 23,4% ($P > 0,05$)) increased, comparative to the I group. β globulins in the II group was by 11,9% ($P > 0,05$), in the III group by 18,5% ($P > 0,05$), and in the IV group - by 24,7% ($P > 0,05$), also increased, comparative to the I group, and the globulin γ level, in the II group was by 16,5% ($P > 0,05$), in the III group by 13,7% ($P > 0,05$), and in the IV group - with 23,6% ($P > 0,05$) higher at infested groups, comparative to the I group, uninfested.

The obtained results indicate that the infestation with *Strongyloides papillosus* causes a proteinogram indices decrease, characteristic for the type I electrophoregram changes, specific to the acute inflammatory processes, due to the mechanical and spoiling action of the rhabditoid larvae, which circulate in the pathogenic microflora in the host organism. Infestation with *Dicrocoelium lanceolatum* leads to the proteinogram's index change and causes respective changes, which expressed the VIII electrophoregram type, specific for the hepatobiliary symptomatic complex, due to the toxic action, mechanical and spoliating action of dichroceles from the liver's bile ducts. In the study's result of the mono- and polyinvasions impact on the plasma hemostasis indices in wild boars, it was established that the prothrombin index's level (PI) in animals from the II group was lower by 16,4% ($P > 0,05$), in those from the III group by 14,2% ($P > 0,05$) and in those from the IV group by 18,2% ($P > 0,05$), comparative to those from the I group. The activated recalcification time (TRA), in wild boars from the II group, has increased comparative to the I group by 16,8% ($P > 0,05$), from the III group by 9,5% ($P > 0,05$) and from the IV group by 18,5% ($P > 0,05$). The activated partial thromboplastin time (aPTT) also increased in wild boars from the II group by 18,7% ($P > 0,5$), in the III group by 11,4% ($P > 0,05$) and in the IV group with 19,1% ($P > 0,05$), comparative to those from the I group. Thrombin time (TT) is in decreasing at infested groups, by 21,3% ($P > 0,05$) in the II group, with 14,9% ($P < 0,05$) in the III group and with 24,6% ($P < 0,05$) in the IV group, comparative to the I group - uninfested wild boars. The fibrinogen content from the I group with uninfested wild boars is higher with 21,2% than in the II group and with 9,7% ($P > 0,05$) than in the III group with monoinfested wild boars, and by 36,6% ($P > 0,05$) than in the IV group with polyinfested wild boars. Ca^{2+} content, is also decreased by 35,5% ($P > 0,05$) in the II group, in the III group by 23,5% ($P > 0,05$) and in the IV group by 44,2% ($P > 0,05$), comparative to the I lot. (tab. 5).

Table 5. Mono- and polyinvasions impact on the plasma hemostasis indices in wild boars

Groups	PI,%	TRA,seconds	aPTT,seconds	TT,seconds	Fibrinogen,g/l	Ca^{2+} ,mmol/l
I	98,3 $\pm$ 3,35	65,4 $\pm$ 2,4	46,6 $\pm$ 1,3	30,4 $\pm$ 1,2	5,2 $\pm$ 0,21	3,4 $\pm$ 0,18
II	82,2 $\pm$ 3,21	78,6 $\pm$ 2,6	57,3 $\pm$ 1,4	38,6 $\pm$ 1,4	4,1 $\pm$ 0,32	2,2 $\pm$ 0,12
III	84,4 $\pm$ 2,79	72,2 $\pm$ 2,1	52,6 $\pm$ 2,1	35,7 $\pm$ 1,3	4,7 $\pm$ 0,33	2,6 $\pm$ 0,24
IV	80,4 $\pm$ 2,21	80,2 $\pm$ 2,6	57,6 $\pm$ 2,6	40,3 $\pm$ 0,30	3,3 $\pm$ 0,18	1,9 $\pm$ 0,12

The obtained results indicate that, both in boars infested with *S. papillosus* from the I group and in those infested with *D. lanceolatum* from the II group, indices was established a hemostatic decrease, and their maximum decrease is highlighted in the IV group with polyinfested wild boars with *Dicrocoelium lanceolatum*, *Strongyloides papillosus*, *Metastrongylus elongatus* and *Eimeria deblickei*. This decrease is due to exotoxins eliminated by parasites, which contain anticoagulant and hemolyzer substances, and which neutralize the fibrinogen, thrombin, Ca⁺ ions and vitamin K properties.

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