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HEMATOLOGY OF BOSNIAN PONY

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Abstract

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This article deals with the possibilities and ways of using relatively simple hematological methods in evaluation of horse welfare and health. It provides an extensive account of data concerning this topic, as well as a brief outline of basic, easily applicable hematological methods. Evaluation of Bosnian Pony welfare and health was estimated using hematological status of stallions, mares and foals and different age groups of this breed. Blood samples were collected from clinically normal animals and analyzed using a hematological analyzer. Red blood cell count (RBC), White Blood Cell Count (WBC), hemoglobin concentration were measured directly; Packed Cell Volume (PCV), Mean Corpuscular Hemoglobin (MCH) and Mean Corpuscular Hemoglobin Concentrations (MCHC) were calculated automatically. Mean values and variation range were determined for stallions, mares and foals. Average values of hematological parameters of adult Bosnian ponies were: WBC = 6.204 $\cdot 10^9$/l, RBC = 9.110$\cdot 10^{12}$/l, PCV = 0.422 l/l, Hb = 159.33 g/l, MCV = 46.16 f/l, MCH = 17.58 pg, MCHC = 383.11 g/l ery., while foals had values: WBC = 9.353 $\cdot 10^9$/l, RBC = 9.860$\cdot 10^{12}$, PCV = 0.384 l/l, Hb = 148.89 g/l, MCV = 38.94 f/l, MCH = 15.32 pg, MCHC = 392.82 g/l ery.. These values are characteristic for this breed and can be used in health evaluation.

*Key words***:** Bosnian Pony, hematology, age groups

Abbreviations: WBC - White Blood Cell Count, RBC - Red Blood Cell Count, PCV - Packed Cell Volume, Hb - Hemoglobin, MCV - Mean Corpuscular Volume, MCH – Mean Corpuscular Hemoglobin, MCHC – Mean Corpuscular Hemoglobin Concentration

Introduction

According to extensive literature (Sykes, 1966; Rubio et al., 1995; Cebulj-Kadunc, 2002), hematology provides relatively simple but reliable methods of establishing physiological status by giving insight in various processes in the horse organism. Thus it is also a good indicator of horse welfare, health, and, indirectly, of ambiental conditions (Gill and Kompanowska-Jezierska, 1986). Therefore, hematological data enable an early and successful diagnosis of general physiological and health status and represent a useful tool of equal importance for both the researchers and the practitioners. It should be emphasized, however, that changes seen in horse blood picture under certain pathological conditions may have specific and nonspecific characteristics. Specific characteristics provide for direct diagnostics of a given pathological condition, while nonspecific characteristics only indicate existence of certain changes in the organism (Sykes, 1966; Schalm, 1975; Yamauchi et al., 1993; Lassen and Swardson, 1995; Cebulj-Kadunc et al., 2003).

However, the precondition for the use of hematological analysis is a sufficient knowledge of normal hematological values. In other words, diagnostics of horse welfare and diseases by means of hematology is only possible when information about ranges of physiological variation of hematological parameters are available (Jablonska et al., 1991). The knowledge of cause and effect ratio between changes in external and internal environment and changes in horse

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blood picture is also necessary (Lassen and Swardson, 1995; Piccione et al., 2005).

Each breed is characterised by specific blood values so the knowledge of their differences is important for application of hematological analyses in evaluation of animal welfare (Lumsden et al., 1980; Rubio et al., 1995; Uysal et al,, 2001; Cebulj-Kadunc et al, 2003; Lacerda et al., 2006).

To achieve this special emphasis must be put on a number of factors affecting hematological status of an individual or of the whole breed. They include age, gender (Cebulj-Kadunc et al., 2002; Pagacz et al., 2004), biological rhythms (Gill and Rastawicka, 1986; Gill and. Kompanowska-Jezierska, 1986; Piccione et al., 2005), environmental impact (Plotka et al., 1988), feed quality and time of feeding (Raymond et al., 2003) reproductive and training status (Jablonska et al., 1991), prior exercise (Andrews et al., 1995) and handling of horses during the blood collection, pathogens and stress (Yamauchi et al., 1993).

There is no doubt that the awareness of these factors is a prerequisite to distinguish between physiological and pathological blood pictures (Rubinoa, et al., 2006). At the same time, they are essential for establishing normal values for a given breed which often fall into a broad range (Schalm et al., 1975; Weiss and Wardrop, 2010). For the horse population of a given breed such values are of great importance for any laboratory or clinic.

Hematological data for several particular horse breeds, as well as for horses in general, are available but still incomplete, especially for endemic and/or rare horse breeds. An extensive account of this was provided by Cebulj-Kadunc et al. (2002).

For the endemic Bosnian Pony (Pilling and Rischkowsky, 2007) no such data have been published yet, so the objective of this study is to determine the hematological parameters of that indigenous breed and any differences associated with the age and gender. These data are expected to contribute to the efforts in conservation of original traits of Bosnian Ponies and could as well be used in future monitoring of Bosnian Ponies' welfare and health.

Materials and Methods

The Bosnian pony, which is an internationally acknowledged ancient breed, belongs to warm-blooded horses. It is believed to have developed through a cross between the tarpan (*Equus caballus gmelini*) and the Asian wild horse (*Equus caballus prsewalskii*). Further infusions of oriental stock have probably been introduced to the breed by the Turks during the Ottoman Empire (Katica, 2004; Ziga and Telalbasic, 2009).

In appearance, the ponies retain a fairly primitive look, which is in line with the Asian Wild Horse, but with greater quality and refinement due to the infusions of oriental blood. They have a heavy head with a straight profile, full forelock and small ears. They have a short muscular neck, with long sloping shoulders, a straight back, sloping quarters, and a wide and deep chest. They are often beige, brown, black or palomino in colour. Stand between 135 and 145 cm withers height, weigh 250-350 kg, and they belong to the largest groups of ponies.

The Bosnian pony has been prized in its area for many centuries and, since 1900s, it has been selectively bred. For many years, the principal breeding center has been the Borike Stud farm in Bosnia (N latitude 43° 52' 40", E longitude 19° 08' 05") at the altitude of 950 m. Stallions and mares have been controlled there by the state authorities and until recently, a set of very strict standards for stallions was applied to ensure that only the strongest specimens were allowed to breed and they were required to compete in performance tests (Ziga and Telalbasic, 2009).

Currently at Borike Stud farm there are 140 Bosnian Ponies reared and bred under controlled conditions. Each horse has a separate file containing all necessary data, and the age of horses is determined on the basis of these data.

Due to careful controls imposed the Bosnian pony is an extremely useful and functional animal, quite capable of light farm work, light draft, pack and riding. It is frequently used for pack purposes, being very surefooted on a terrain unsuitable for motor vehicles.

All the ponies, except stallions, are reared in outdoor conditions, on pastures of a mountainous plateau (in an area of 28 km^2). During the winter period they are also mostly outdoors, but fed with hay. They are free to enter the stables under unfavourable weather conditions.

In this study hematological parameters of 49 Bosnian Ponies from Borike Stud farm were estimated: 13 stallions, 23 mares and 13 foals. The stallions were aged 4-17 years (average 7.2 years), the mares were aged 6-19 years (average age 9.0 years) and the foals were aged 3-11 months (average age 6.7 months).

Blood samples were collected from clinically healthy animals free from internal and external parasites.

The relationship between the ponies' age and their hematological parameters was studied by using either the exact age expressed in years (Factor analysis) or the age groups (ANOVA, multiple comparisons). The ponies were divided in five age groups. Group I included foals, ponies aged less than one year; group II included ponies aged 4, 5 and 6 years; group III included ponies aged 7, 8 and 9 years; group IV included ponies aged 11, 12, 13

and 14 years; group **V** included ponies aged 15 years or more.

On the day of blood sampling, all usually free-running animals were tethered. Sampling was performed in accordance with animal welfare legislation and approved by the Veterinary administration of the Republic of Bosnia and Herzegovina (Official Gazette, 2009). As the horses were familiar with humans and used to various handling procedures, no restraint was necessary. Blood was collected from the jugular vein between 8 and 11 am,. The time of sampling proved to be important because of well expressed diurnal rhythmicity (Piccione et al., 2005). Blood samples were taken by double-ended needles and evacuated tubes with K_2EDTA as anticoagulant (Vacutainer®, Becton Dickinson Systems Europe). The samples were stored for 24 h according to Clark et al. (2002).

The blood was analyzed using a hematological analyzer (ABOTT CELL DYN 3700 system, Bayer, Germany). Red Blood Cell Count (RBC), White Blood Cell Count (WBC), hemoglobin concentration and Packed Cell Volume (PCV) were measured directly while, Mean Corpuscular Volume (MCV), Mean Corpuscular hemoglobin (MCH) and Mean Corpuscular Hemoglobin Concentration (MCHC) were calculated using values for RBC, PCV and Hb concentration.

Descriptive and analytical statistics were performed in accordance with Fowler et al. (1998) and Dytham (2003) using Microsoft Excel and Statistical Package for Social Sciences (SPSS for WINDOWS, release 16.0). For lower and upper limits of variation minimum and maximum values were used (Lumsden et al., 1980; Dytham, 2003).

Results

Hematological parameters of adult's ponies and foals

The values of hematological parameters of Bosnian Ponies are presented for stallions, mares, total adults and foals with designated 95% Confidence Interval for Mean and lowest and highest value (Table 1). Because of the small number of Bosnian Ponies kept at Borike Stud the sample is small too, so that minimum and maximum observations may be better for estimation of the Confidence Interval.

The ratios between age groups and hematological parameters are shown in Table 2, while Factor analysis is shown in Table 3.

Statistically significant differences between stallions and mares were found in three hematological parameters. Stallions had significantly higher values of all the three parameters - RBC, ($p = 0.008$), PCV ($p = 0.003$) and hemoglobin concentration ($p = 0.001$) than mares.

However, WBC, MCV, MCH and MCHC values were very close in stallions and mares.

Several hematological parameters differed significantly in foals from those in adult ponies. WBC was higher ($p = 0.006$) while MCV ($p = 0.000$) and MCH ($p = 0.035$) were lower in foals than in adult ponies of both sexes.

Differences in RBC, PCV and hemoglobin concentration values between foals and adult ponies were gender dependent. It was found that in foals PCV ($p = 0.003$) and hemoglobin concentration ($p = 0.006$) were lower than in stallions, while RBC was higher than in mares ($p = 0.024$).

Gender influence on hematological parameters was established in foal population as well. Both MCH (16.62 ± 1.26 pg) and MCHC (407.29 ± 41.75 g/l erythrocytes) values were higher in colts than in fillies (14.02 ± 2.15 pg and 378.35 ± 31.71 g/l erythrocytes, respectively). The differences were significant at the 0.05 level.

The broader range of values of hematological parameters is very probably caused by comparatively small sample size resulting from small number of pure-breed Bosnian Ponies in their autochthonous habitat (60).

Hematological parameters and age

The relationship between hematological parameters and the age of Bosnian Ponies were analyzed by means of ANOVA multiple comparisons and Factor analysis. ANOVA testing was performed with age groups and factor analysis in animals of the exact age.

In Table 2 detailed data of hematological values for all studied age groups are given. Generally, low coefficient of variation found for all parameters in all groups shows consistency of data within the age groups.

However, there are marked differences between age groups. Group I, ponies aged up to one year, had higher values of WBC and RBC and lower values of Hb concentration, MCV and MCH. WBC values were significantly higher than in any other age group, while RBC values differed significantly only from group IV.

Hemoglobin concentration was significantly lower than in group II.

MCV values were significantly lower than those found in almost all other age groups (II, III, and IV).

MCH values were significantly lower than the values found in groups II and IV.

Two of the analyzed hematological parameters, PCV and MCHC, had similar values in all age groups. This fact is of great importance for the use of hematology in diagnostics and we would recommend that these two parameters be analyzed first. If they differ from standard values, additional analyses are required.

Age group V, which consisted of only two ponies (one stallion and one mare), was specific not only for low WBC values, but also for high both RBC and PCV and low values of MCH and MCHC.

Type of distribution

Values of all studied hematological parameters were tested for normality of distribution by Shapiro-Wilk's test. The distribution analysis has shown that most of the investigated hematological parameters had normal type of distribution, being of considerable importance for their applicability.

The exceptions were RBC values in stallions ($p = 0.009$) and fillies ($p = 0.044$) and MCHC values in mares ($p = 0.001$).

In stallions, the RBC curve was moderately right skewed (1.945), i.e. there were infrequent but high RBC values. It was high leptokurtic (4.438) proving that most of the values were grouped near the mean, with a higher probability than it would be normally expected.

In fillies distribution of RBC values differed from normal as well. The curve was slightly right skewed (1.052) but contrary to the situation found in stallions, it was platykurtic

Table 1
Hematological values* of Bosnian Pony stallions, mares, total adults and foals

Parameter	Category	No	Mean ± SD	Coef. of variat %	95% Confidence Interval for Mean		Min. value	Max. value
					Lower Bound	Upper Bound		
WBC x 10^9/l	Stallions	13	6.204 ± 2.386	38.46	4.762	7.646	3.150	10.550
	Mares	22	6.330 ± 1.676	26.47	5.587	7.073	3.150	10.450
	Tot. add	35	6.204 ± 2.386	30.81	5.618	6.948	3.150	10.550
	Foals	13	9.353 ± 2.886	30.90	7.609	11.100	2.250	13.050
RBC x 10^{12}/l	Stallions	12	9.913 ± 1.293	13.04	9.092	10.730	8.652	13.380
	Mares	22	8.672 ± 1.168	13.47	8.154	9.189	6.180	10.360
	Tot. add	34	9.110 ± 1.337	14.68	8.643	9.576	6.180	13.800
	Foals	12	9.860 ± 1.765	17.90	8.738	10.980	6.250	13.160
PCV l/l	Stallions	13	0.463 ± 0.054	11.59	0.431	0.496	0.380	0.560
	Mares	23	0.399 ± 0.061	15.25	0.372	0.425	0.252	0.555
	Tot. add	36	0.422 ± 0.066	15.54	0.400	0.444	0.380	0.560
	Foals	13	0.384 ± 0.067	17.40	0.344	0.425	0.230	0.500
Hb, g/l	Stallions	13	176.64 ± 22.41	12.69	163.09	190.18	134.90	203.88
	Mares	23	149.55 ± 19.69	13.16	141.03	158.06	90.44	191.52
	Tot. add	35	159.33 ± 24.29	15.24	151.11	167.55	90.44	203.88
	Foals	12	148.89 ± 23.74	15.90	133.81	163.97	111.14	206.15
MCV, fl	Stallions	12	46.88 ± 5.16	11.01	43.60	50.16	36.40	55.10
	Mares	22	45.76 ± 6.66	14.56	42.81	48.72	30.73	61.64
	Tot. add	34	46.16 ± 6.12	13.25	44.02	48.29	30.73	61.64
	Foals	12	38.94 ± 3.67	9.40	36.61	41.27	32.51	43.74
MCH, pg	Stallions	12	18.00 ± 3.48	19.30	15.79	20.21	10.08	22.47
	Mares	22	17.35 ± 2.93	16.88	16.05	18.65	10.79	24.17
	Tot. add	34	17.58 ± 3.10	17.61	16.50	18.66	10.08	24.17
	Foals	12	15.32 ± 2.16	14.10	13.95	16.69	10.76	18.01
MCHC, pg/l ery	Stallions	13	385.56 ± 61.81	16.03	348.21	422.91	277.00	474.20
	Mares	23	381.73 ± 67.67	17.73	352.47	410.99	202.33	594.13
	Tot. add	36	383.11 ± 64.74	16.90	361.21	405.02	202.33	594.13
	Foals	12	392.82 ± 38.44	9.78	368.40	417.24	331.06	483.21

*WBC = white blood cell count; RBC = red blood cell count; PCV = packed cell volume; Hb = hemoglobin concentration; MCV = mean corpuscular volume; MCH = mean corpuscular hemoglobin; MCHC = mean corpuscular hemoglobin concentration.

(-1.048), meaning that distribution width was high. There were less values distributed near the mean than in normal distribution and at the same time more extreme values (lower or higher than mean) were distributed in "thin tails".

Table 2
Hematological parameters in different age groups of Bosnian Ponies*,*

Parameter	Age group	No	Mean	SD	SE	95% Confidence Interval for Mean		Min. value	Max. value	Coeff. of var. %
						Lower Bound	Upper Bound			
WBC x 10^9/l	I	13	9.353^a	2.886	0.800	7.609	11.100	2.250	13.050	30.9
	II	10	7.395^b	1.997	0.632	5.966	8.823	5.050	10.550	27.0
	III	17	5.818^b	1.915	0.464	4.833	6.802	3.150	10.450	32.9
	IV	6	6.496^b	1.144	0.467	5.295	7.697	5.000	8.250	17.6
	V	2	4.050^b	1.414	0.100	-	-	3.950	4.150	3.5
RBC x 10^{12}/l	I	12	9.860^a	1.765	0.509	8.738	10.980	6.250	13.160	17.9
	II	9	9.296	0.927	0.309	8.584	10.010	7.400	10.480	10.0
	III	17	9.106	1.545	0.375	8.312	9.900	6.700	13.380	17.0
	IV	6	8.378^b	1.112	0.454	7.212	9.545	6.180	9.230	13.3
	V	2	10.500	0.622	0.440	-	-	10.060	10.940	5.9
PCV, l/l ery	I	13	0.384	0.067	0.019	0.344	0.425	0.230	0.500	17.4
	II	10	0.435	0.048	0.015	0.400	0.469	0.360	0.511	11.0
	III	18	0.421	0.074	0.017	0.384	0.458	0.252	0.555	17.5
	IV	6	0.387	0.040	0.016	0.345	0.429	0.346	0.455	10.3
	V	2	0.474	0.122	0.086	-	-	0.388	0.560	25.7
Hb, g/l	I	12	148.89^a	23.74	6.85	133.81	163.97	111.14	206.15	15.9
	II	10	171.17^b	21.12	6.68	156.06	186.27	136.89	200.65	12.3
	III	18	155.74	25.33	5.97	143.15	168.34	90.44	203.87	16.3
	IV	6	151.78	27.21	11.11	123.22	180.34	125.40	203.88	17.9
	V	2	155.04	3.76	2.66	-	-	152.38	157.70	2.4
MCV, fl	I	12	38.94^a	3.67	1.06	36.61	41.27	32.51	43.74	9.4
	II	9	46.57^b	3.33	1.11	44.01	49.13	40.64	51.64	7.2
	III	17	45.92^b	7.48	1.82	42.07	49.77	30.73	61.64	16.3
	IV	6	46.64^b	5.72	2.33	40.64	52.64	40.52	56.80	12.3
	V	2	44.88	8.92	6.31	-	-	38.57	51.19	19.9
MCH, pg	I	12	15.32^a	2.16	0.62	13.95	16.69	10.76	18.01	14.1
	II	9	18.15^b	1.58	0.53	16.93	19.36	16.53	21.58	8.7
	III	17	17.33	3.51	0.85	15.52	19.13	10.08	23.42	20.3
	IV	6	18.38^b	3.88	1.59	14.30	22.45	14.68	24.17	21.1
	V	2	14.78	0.52	0.37	-	-	14.42	15.15	3.5
MCHC, g/l ery	I	12	392.82	38.44	11.10	368.40	417.24	331.06	483.21	9.8
	II	10	395.23	40.78	12.89	366.06	424.39	339.10	474.20	10.3
	III	18	378.83	80.78	19.04	338.66	419.00	202.33	594.13	21.3
	IV	6	391.08	40.63	16.59	348.45	433.72	336.63	448.09	10.4
	V	2	337.17	78.58	55.56	-	-	281.61	392.73	23.3

*Age groups: I = up to 1 year; II = 4, 5 and 6 years; III = 7, 8 and 9 years; IV =11, 12, 13 and 14 years; V = aged 15 years or more
**Mean values of the same hematological parameter with different letters in superscript are significantly different ($p < 0.05$) in designated age classes. Figures without any letter in superscript are not different.

In mares, only the distribution of MCHC values differed from normal. The curve was only slightly right skewed (0.590) but was highly leptokurtic (5.843) proving that most of the values were distributed close to the mean.

These deviations from normal distribution suggest that additional researches are required to prove whether the identified curves are caused by small sample size or show the true characteristics of the given parameter and pony category and that some of the standardized statistical methods of transformation should be applied. It is recommended to use the whole range of values (minimum – maximum) as reference values.

Factor analysis

Factor analysis was performed to establish which of the studied features represent main components and characterize the hematological features of the studied group of Bosnian Pony best (Table 3).

The first component ("age component") consisted of age, WBC and MCV. WBC was in negative correlation both with age and MCV. This component we designated "age component" and it clearly showed that in Bosnian Ponies increase in age was accompanied by the increase of MCV values and decrease of WBC values.

The second component ("erythrocytic component") consisted of RBC and HCT in highly positive correlation.

The third component ("hemoglobin component") consisted of hemoglobin concentration, MCH and MCHC values.

Highly positive correlations found between variables of the second and the third principal components are normal consequences of the relationship between hematological parameters.

The values of the basic hematological parameters of Bosnian Pony from the Borike Stud show that this breed has consistent and well defined characteristics. They are clearly correlated with age and gender.

Table 3
Factor analysis

	Component		
	1	2	3
AGE	0.753	-0.112	-0.101
WBC	-0.698	-0.068	0.059
RBC	-0.347	0.874	-0.189
HCT	0.327	0.908	0.121
HB	-0.032	0.572	0.857
MCV	0.775	0.050	0.310
MCH	0.288	-0.274	0.865
MCHC	-0.386	-0.449	0.685

Discussion

Hematological parameters of Bosnian pony have not been investigated before, so, our results can not be compared to findings of other authors. On the other hand, comparison with normal hematology of other horse breeds is necessary to illustrate more clearly the characteristic of the Bosnian Pony hematology.

In our study, it was established that stallions had significantly higher values of all RBC, PCV and Hb concentration than mares. This correlates with results of Plotka et al. (1988) of feral horses.

Studying Lipizzan hematology, Čebulj-Kadunc et al. (2002) also found significantly higher RBC and hemoglobin concentration values in stallions than in mares but almost similar WBC values. However, Lacerda et al. (2006) did not find significant differences in hematological parameters of stallions and mares of the three breeds investigated - thoroughbreds, Brasileiro de Hipismo and Criollo.

Čebulj-Kadunc et al. (2003) also found differences in hematological parameters (WBC and differential leukocyte count) between male and female foals during the first four months of life. The same authors (Čebulj-Kadunc et al., 2002; 2003) also found that in Lipizzan mares and stallions WBC values decreased with age.

In general, with the exception of WBC, the values of hematological parameters of Bosnian Ponies are in the upper range of normal values cited for many horse breeds.

The mean values for warm blooded horses older than 5 years referred by Schalm et al., (1975) for RBC (8.57 ± 0.98 x 10^{12}/l), PCV (0.41 ± 0.04 l/l), Hb concentration (144 ± 1.6 g/l), MCH (16.8 ± 1.3 pg) and MCHC (354 ± 14 g/l) were lower than in adult Bosnian Ponies from the Borike Stud. On the contrary, MCV (47.7 ± 4) and WBC (8.82 ± 1.76 x 10^{9}/l) were higher. Differences were the greatest in hemoglobin concentrations.

Also, the upper limits (of the range) of the RBC, Hb concentration, PCV, MCV, MCH and MCHC values determined in Bosnian Ponies are much higher than the reference values given by Jeffcot (1979) for warm blooded horses.

Comparison with values of hematological parameters of warm blooded horses (2 thoroughbred and 2 standardbred mares and 2 thoroughbred geldings) found by Clark et al., (2002) showed that Bosnian Ponies have higher RBC, PCV, Hb concentration, MCV, MCH values and lower WBC values, while MCHC values were similar.

Results obtained by Lacerda et al. (2006) who studied hematology of thoroughbreds and two Brazilian breeds (Brasil-

eiro de Hipismo and Criollo) showed that in mature thoroughbreds of both sexes the RBC, PCV and hemoglobin concentration values were lower than in adult Bosnian Ponies, while WBC values were higher.

The same relationship was found when the above mentioned values were compared with those of the two Brazilian breeds.

Compared to Arabian horses (Bilal and Meral, 2002) adult Bosnian Ponies show higher mean values of hemoglobin concentration, MCV, MCH and MCHC, and lower WBC and RBC values.

In comparison with Standardbred horses (Lumsden et al., 1980) mature Bosnian Ponies have higher mean values of RBC, PCV, hemoglobin concentration, MCV, MCH and MCHC and lower WBC values.

Comparison with the data obtained for recently rediscovered Caspian miniature horses in the analyses of hemoglobin concentration and hemoglobin types made by Nazifi and Rategh (2005) was very interesting. Bosnian Ponies of both genders and of all age classes had higher values of total hemoglobin concentration.

When comparisons are made with horses of the same gender the situation is somewhat different.

The data relating to thoroughbred mares established by Lumsden et al. (1980) show that Bosnian Pony mares have higher MCH and MCHC values and lower RBC and WBC values. Mean values of other hematological parameters (PCV, Hb concentration, MCV) did not differ between mares of these two breeds.

In Bosnian Pony stallions RBC, PCV, Hb concentration, MCH and MCHC values were higher than in Lipizzan stallions (Cebulj-Kaduncet al., 2002) while WBC and MCV values were lower.

Mares of these two breeds show similar relationship between their hematological parameters. Bosnian Pony mares had higher mean values of RBC, Hb concentration, MCH and MCHC and lower WBC, PCV and MCV values than Lipizzan mares.

Hematological parameters of Bosnian Pony foals (aged 6 to 11 months) were compared with those of Thoroughbred and Lipizzan foals.

Mean values of hemoglobin concentration, MCV, MCH and MCHC were higher, while RBC and WBC values were lower than in Thoroughbred foals aged 0.5 to 2 months (Lumsden et al., 1980).

In comparison with Lipizzan foals aged 0.5 to 4 months Bosnian Pony foals had higher RBC, Hb concentration, MCH and MCHC values and lower MCV and WBC values (Cebulj-Kadunc et al., 2002).

Compared to Standard bred foals aged 3.25 months Bosnian Pony foals had higher MCH values, but lower RBC and Hb concentration values (Komosa et al., 1990).

Compared with two groups of Arabian foals studied by Gill and Kompanowska- Jezierska (1986) in two different years, Bosnian Pony foals had lower RBC values than any group of Arabians. However, hemoglobin concentration and PCV values of Bosnian Pony foals were higher than in Arabian foals of one group and lower than in the foals of the other group. The age of Arabian foals from both groups corresponded to that of the Bosnians.

In foals, especially during the first 4 months, considerable changes in the values of their hematological parameters were established, so the comparisons should be done between foals of similar age (Gill and Kompanowska-Jezierska**,** 1986; Komosa et al., 1990; Cebulj-Kadunc et al., 2002).

Conclusions

The values of the basic hematological parameters of Bosnian Pony from the Borike Stud show that this breed has consistent and well defined characteristics. The distribution analysis has shown that most of the investigated hematological parameters had normal type of distribution, being of considerable importance for their applicability.

In general, with the exception of WBC, the values of hematological parameters of Bosnian Ponies are in the upper range of normal values cited for many horse breeds.

Stallions had significantly higher values of RBC, PCV and hemoglobin concentration than mares while WBC, MCV, MCH and MCHC values were very close in stallions and mares. Gender differences were also noted in foals where MCH and MCHC values were higher in colts than in fillies.

Hematological parameters differ in ponies of different age classes, being the most prominent between class I and other age classes, in most of the parameters.

Increase in age was accompanied by the increase of MCV values and decrease of WBC values. Foals had significantly higher values of WBC and lower values of MCV and MCH than in adult ponies of both sexes.

Two of the analyzed hematological parameters, PCV and MCHC, had similar values in all age groups. This fact is of great importance for the use of hematology in diagnostics and we would recommend that these two parameters be analyzed first. If they differ from standard values, additional analyses are required.

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