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THE HAEMATOLOGY AND SERUM BIOCHEMISTRY OF WILD FALLOW DEER *(Dama dama)* IN NEW SOUTH WALES

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Abstract: Fallow deer *(Dama dama)* were captured in an enclosure trap in southern New South Wales. Blood samples were collected for determination of haematological and biochemical values after capture and in one group after 3 h of transportation. Results were compared between fawns and does, transported and non-transported fawns, and transported and non-transported does. Fawns had higher haemoglobin, total red cell count, packed cell volume and lymphocyte numbers, but lower red cell indices and eosinophil numbers than does. Fawns also had lower levels of serum globulin than does, resulting in a higher albumin/globulin ratio in the former. The fawns had higher inorganic phosphorus, alkaline phosphatase and creatine kinase but lower glucose and urea nitrogen. There were only minor differences in red cell parameters and indices between transported deer but there were significant differences in the differential leucocyte counts, with the former having a relative neutrophilia with left shift, lymphopaenia and eosinopaenia. The effects of transport were also reflected in higher activities of the muscle enzymes aspartate aminotransferase, creatine kinase and lactate dehydrogenase. The non-transported deer had higher total white cell counts and higher lymphocyte and eosinophil counts than have been found previously in fallow deer.

INTRODUCTION

Fallow deer *(Dama dama)* are the commonest deer in Australia, both in the wild and in captivity.[1,3] Published data on the haematology and serum and plasma biochemistry of fallow deer are based on results obtained from relatively few animals,[4] or from farm deer chemically immobilized or shot prior to blood sampling.[9,10]

The effects of exertion or sedation on blood values are well recognized,[4] and these factors must be considered when interpreting the results determined from excitable species such as deer. The capture of wild fallow deer in a highly successful enclosure trap[5] provided an opportunity to sample a deer population which had not been subjected to the effects of severe exertion, sedation or domestication at the time of blood collection.

MATERIALS AND METHODS

Deer Capture. A 2 ha enclosure trap was used between February and October, 1979, to capture 231 black fallow deer with only one mortality (0.4%). The success of this trapping operation is attributed to the careful placement of the trap, the use of food to attract deer into the enclosure and the handling and translocation of captured deer at night, resulting in an almost complete lack of exertion or panic in deer handled in this way.[5]

Blood sampling. This was carried out immediately after the deer were captured at night. Deer were physically restrained in a catching pen within the enclosure. Adult does and fawns 2 to 12 weeks of age were sampled in this way, the exception being 7 does and 7 fawns sampled after a 3 h trip in an enclosed trailer. This vehicle was provided with hay on the

floor, and the deer were not restrained or sedated during the trip.

Blood samples were collected from the jugular vein using evacuated tubes with 18 gauge needles. EDTA tubes were used for haematology, plain tubes were used for serum collection to perform biochemical tests and electrophoresis. Lithium heparin tubes were used to collect plasma for electrolyte and osmolality determinations.

Standard haematologic techniques were used to determine erythrocyte (RBC), leucocyte (WBC) and haemoglobin (Hb) values. Mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) values were calculated.

Biochemical profiles were compiled by the use of a Technicon SMA 12/60 autoanalyser. The fibrinogen was derived by subtracting the total protein value of each serum, as read on a refractometer from the refractometer value of its respective EDTA plasma.

Sodium and potassium values were obtained with the use of a flame photometer and the chloride level determined coulometrically with a chloride meter. Osmolality values were determined by the freezing point method. Electrophoretic patterns were determined with cellulose acetate strips.

Standard statistical methods were used to determine means and standard deviations. The Student's T test was used to determine statistical differences.

RESULTS

Blood samples were obtained from 30 does and 13 fawns, including 7 does and 7 fawns sampled after transport. The haematology and serum and plasma biochemistry are presented in Tables 1, 2, 3 and 4.

Fawns had higher red cell parameters than does, namely Hb, RBC and PCV, but lower red cell indices (MCV, MCH and MCHC). There was no difference between fawns and does in total WBC, but fawns had higher lymphocyte and lower eosinphil numbers than does (Table 1). There was a higher level of plasma protein in does than in fawns (Table 2), but lower levels of globulins, resulting in a higher albumin/globulin (A/G) ratio in the latter (Table 3).

Fawns had higher inorganic phosphorus (IP), alkaline phosphatase (AP) and creatine kinase (CK) than does, but lower glucose and blood urea nitrogen (BUN) (Table 2). There were no significant differences in plasma electrolytes or osmolality between fawns and does (Table 4).

There were minor differences in red cell parameters and indices between transported and non-transported deer, with transported fawns having higher RBC and lower MCH than non-transported fawns, and transported does having lower Hb and PCV than non-transported ones. Even though there were no significant differences in total WBC between transported and non-transported deer, there were substantial differences in the differential leucocyte counts. In both age groups the effects of transport were a neutrophilia with left shift, lymphopaenia and eosinopaenia (Table 1).

Significant differences in serum biochemistry were observed between transported and non-transported deer. In particular, the activities of the serum enzymes creatine kinase (CK), aspartate aminotransferase (AspAT) and lactate dehydrogenase (LDH) were substantially higher in the transported deer (Table 2). On the other hand $\gamma 2$ globulin levels were lower in transported fawns, as were $\gamma 1$ globulins in does, but in the latter $\gamma 2$ globulins were higher. This resulted in significantly lower total serum protein in transported does, but not in fawns (Table 3).

TABLE 1. The haematology of fallow deer *(Dama dama)* trapped in southern New South Wales

Group		Hb g/L	RBC x10^{12}/L	WBC x10^{9}/L	PCV L/L	MCV fL	MCH pg	MCHC g/L	Leucocytes (absolute) Neutrophils Band.	Neutrophils Seg.	Lym.	Mon.	Eos.
Fawns (2-12 wks) (n = 13)		175.08	12.69	5.69	0.469	36.28	13.77	369.23	110.85	3082.62	2197.31	246.23	55.31
	SD±	8.84	0.71	1.04	0.021	2.21	0.66	10.92	107.74	1431.74	1061.60	103.71	88.36
Does (n = 28)		159.04	9.59	4.69	0.414	43.44	16.60	380.50	116.29	2635.00	1430.50	259.43	237.32
	SD±	18.17	1.40	1.86	0.044	2.78	1.09	13.19	171.31	1523.71	761.16	245.90	242.33
	p	<0.005	<0.001	ns	<0.001	<0.001	<0.001	<0.02	ns	ns	<0.02	ns	<0.02
Transported Fawns (n = 6)		176.00	13.10	6.25	0.480	36.42	13.35	364.17	182.17	4376.50	1385.00	283.50	22.83
	SD±	7.69	0.72	0.91	0.020	1.30	0.22	12.72	117.83	871.65	156.90	107.96	36.11
Non-transported Fawns (n = 7)		174.29	12.34	5.21	0.460	36.17	14.13	373.57	49.71	1973.57	2893.57	214.29	83.14
	SD±	10.26	0.53	0.95	0.020	2.89	0.72	7.48	46.88	597.94	1004.03	96.02	112.11
	p	ns	<0.05	ns	ns	ns	<0.05	ns	<0.02	<0.001	<0.005	ns	ns
Transported Does (n = 7)		143.57	8.76	5.10	0.377	42.93	16.31	365.43	326.43	3652.14	904.29	186.14	33.86
	SD±	12.55	0.87	1.06	0.031	1.92	0.34	14.51	216.47	783.15	394.46	67.52	46.25
Non-transported Does (n = 21)		164.19	9.86	4.54	0.426	43.61	16.70	381.86	46.24	2292.52	1604.19	283.86	305.15
	SD±	16.93	1.45	2.06	0.041	3.03	1.23	12.80	70.38	1571.82	779.73	278.84	243.55
	p	<0.01	ns	ns	<0.01	ns	ns	ns	<0.001	<0.05	<0.05	ns	<0.01

DISCUSSION

An age difference in the haematocrit of these fallow deer was not unexpected, since it is considered that the composition of the blood of white-tailed deer *(Odocoileus virginianus)*, mule deer *(Odocoileus hemionus)* and roe deer *(Capreolus capreolus)* reaches adult values by about 6 months of age,[1] and the fawns in the present study were much younger than this. There was no difference in the total WBC between fawns and does, however, and this supports the published data for a number of species of deer, in which there were no marked species, sex or age differences in the concentration of white blood cells.[1] The higher eosinophil count in does was perhaps due to an increased opportunity for exposure to endoparasites in the older animals.[7]

However, the WBC counts are not as low as other published data for fallow deer, nor do neutrophils predominate to the same extent.[4,9,10] One of the most characteristic features of deer blood is the low WBC, with values of 2.0 to 3.0 × 10^{9}/l being common,[1] but many of the published results are likely to reflect the effects of stress from restraint on both the total WBC and on relative numbers of lymphocytes and eosinophils.[11]

Levels of IP and AP have been found to be higher in young animals than in adults for a number of species, including fallow and white-tailed deer,[2,4] and in red deer *(Cervus elaphus)* there was a significant decrease in serum AP with increasing age.[8] The results of this study show similar age differences in both IP and AP (Table 2).

There was a higher level of plasma protein in does than in fawns, with slightly higher serum albumin levels in fawns than in does (Table 2). Electrophoresis of serum proteins showed no significant difference between the two age groups in the level of albumin, but there was a difference in globulins, with fawns having lesser amounts of both the

TABLE 2. Serum biochemistry of fallow deer *(Dama dama)* trapped in southern New South Wales

Group		Ca mmol/L	IP mmol/L	Glucose mmol/L	BUN mmol/L	Albumin g/L	Total Bilirubin umol/L	AlAT U/L*	AspAT U/L*	CK U/L*	LDH U/L*	AP U/L*	Plasma Protein g/L	Fibrinogen g/L
Fawns (2-12 wks)		2.36	2.65	5.15	6.08	35.26	12.56	57.42	182.58	2940.17	973.25	252.42	63.00	5.55
(n = 12)	SD±	0.11	0.57	0.82	1.21	1.85	3.40	16.97	62.85	2246.03	225.87	69.53	3.21	3.64
Does		2.27	1.15	6.32	8.62	33.84	10.97	69.17	190.67	1393.60	830.47	100.57	68.91	5.05
(n = 30)	SD±	0.16	0.42	1.80	2.93	3.42	5.94	19.54	78.89	2040.63	266.11	43.54	3.78	1.68
	p	ns	<0.001	<0.05	<0.01	ns	ns	ns	ns	<0.05	ns	<0.001	<0.001	ns
Transported fawns		2.31	2.91	4.71	6.33	34.27	14.00	57.86	210.71	4594.43	1107.29	230.43	63.83	7.33
(n = 7)	SD±	0.08	0.34	0.55	0.68	1.31	1.53	7.58	70.17	1242.57	187.33	30.92	3.06	4.13
Non-transported fawns		2.44	2.30	5.76	5.72	36.64	7.50	56.80	143.20	624.20	786.00	283.20	62.29	3.40
(n = 5)	SD±	0.10	0.67	0.78	1.78	1.65	3.54	26.56	12.42	251.34	111.82	99.14	3.40	1.14
	p	<0.05	ns	<0.02	ns	<0.02	< 0.005	ns	ns	<0.001	<0.01	ns	ns	ns
Transported does		2.08	0.79	7.67	6.79	30.31	20.71	58.57	265.71	4941.71	1183.71	77.00	65.43	5.57
(n = 7)	SD±	0.14	0.22	2.63	1.06	1.81	3.40	24.18	78.95	834.52	339.95	18.28	2.37	2.76
Non-transported does		2.33	1.26	5.91	9.18	34.89	8.00	72.39	167.83	313.74	722.91	107.74	70.53	4.80
(n = 23)	SD±	0.12	0.40	1.27	3.11	3.02	1.98	17.24	64.56	272.85	100.10	46.66	3.18	0.86
	p	<0.001	<0.01	<0.05	ns	< 0.001	< 0.001	ns	<0.005	<0.001	<0.001	ns	<0.001	ns

*One unit (U) of enzyme is that amount which will catalyse the transformation of one micromole of substrate per minute under defined conditions (U/L = mU/ml)

TABLE 3. Electrophoresis of serum proteins in fallow deer *(Dama dama)* trapped in southern New South Wales.

Group		Albumin g/L	λ1 g/L	λ2 g/L	β g/L	γ1 g/L	γ2 g/L	Total Protein g/L	A/G Ratio
Fawns (2-12 wks)		37.50	3.67	3.83	6.50	2.58	2.92	56.83	1.95
(n = 12)	SD±	2.15	0.65	1.11	0.80	0.51	0.67	3.16	0.17
Does		38.54	3.63	3.46	6.17	5.50	7.42	64.46	1.50
(n = 24)	SD±	3.04	0.88	0.93	1.13	1.96	1.41	3.48	0.19
	p	ns	ns	ns	ns	<0.001	<0.001	<0.001	<0.001
Transported Fawns		37.14	3.71	3.57	6.29	2.43	2.57	55.86	2.00
(n = 7)	SD±	2.27	0.76	1.13	0.76	0.53	0.53	2.54	0.19
Non-transported Fawns		38.00	3.60	4.20	6.80	2.80	3.40	58.20	1.89
(n = 5)	SD±	2.12	0.55	1.10	0.84	0.45	0.55	3.70	0.13
	p	ns	ns	ns	ns	ns	<0.05	ns	ns
Transported Does		35.67	3.33	4.17	5.00	3.67	8.50	60.17	1.48
(n = 6)	SD±	1.86	0.82	1.47	0.63	0.82	1.64	1.72	0.22
Non-transported Does		39.50	3.72	3.22	6.56	6.06	6.83	65.89	1.51
(n = 18)	SD±	2.75	0.89	0.55	0.98	1.95	1.50	2.61	0.19
	p	<0.005	ns	<0.05	<0.005	<0.01	<0.05	<0.001	ns

TABLE 4. Plasma electrolytes and osmolality of fallow deer *(Dama dama)* trapped in southern New South Wales.

Group		Na mmol/L	K mmol/L	Cl mmol/L	Osmolality mmol/Kg
Fawns (2-12 wks)		144.00	7.58	104.00	291.00
(n = 6)	SD±	5.06	0.93	1.41	3.52
Does		143.31	7.62	104.62	288.67
(n = 13)	SD±	6.69	1.40	2.69	3.24
	p	n.s.	n.s.	n.s.	n.s.

$\gamma 1$ and $\gamma 2$ fractions (Table 3). Fawns also had a higher A/G ratio, these results being similar to those for mule and white-tailed deer, in which serum albumin increases rapidly after birth, with serum globulin levels declining rapidly after colostral intake ceases, before increasing to adult levels.[1] The results of serum electrophoresis in red deer are similar to those of the present study.[3]

The effects of transport stress on the differential WBC of deer were shown to be significant decreases in lymphocytes and eosinophils in the transported deer when compared to the animals sampled before transport, with a concurrent increase in immature neutrophils (Table 1).

The substantial increases in transported deer in the activities of the serum enzymes CK, AspAT and LDH, all of which have been well correlated with muscle damage in many species,[2,4,6] highlight the potential ill-effects of even moderate stress on deer. In particular, it should be noted that there was a seven-fold increase in the activity of serum CK (Table 2), even though none of these deer showed any clinically detectable problems after release from the vehicle. There is good evidence that the activities of these muscle enzymes do not return to normal for up to 2 weeks after the exertion which caused the elevations,[6] emphasising the importance of not re-stressing deer during this period.

The activities of the serum enzymes in the non-transported deer are probably as close to normal as can be expected for wild deer, and provide useful reference values for farmed fallow deer. Similarly, the changes induced by transportation in the differential leucocyte count and in the serum proteins enable an evaluation of the effects of routine procedures such as yarding and transport on farm deer. The results of this study provide reference values for both fawns and does in a population of fallow deer which has had little interference from man. Thus, as more fallow deer are farmed in Australia, the effects of domestication and husbandry procedures on their haematology and serum biochemistry can be determined.

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