

HEMATOLOGY, SERUM CHEMISTRY AND PHYSIOLOGICAL CHARACTERISTICS OF CAPTIVE SOUTH PUDU *PUDU PUDU*

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INTRODUCTION

The south pudu or Chilean deer, (*Pudu pudu*, Molina 1782) inhabits exclusively the south of Chile and Argentina, between 35 S and 53 S (Hershkowitz 1982) with an altitude limits of 1000 m. (Tamayo and Frassinetti 1982). Wild populations are scarce, so they are protected by law in Chile. (Stutzin 1992).

The habitat of pudu are great lakes and dense always green forests, with predominance of *Nothofagus dombeyi*, *N. alpina* and *N. Obliqua*. Diet is composed mostly of moss, shrubs and brambleberries (*Rubus spp.*). Pudú is a prey for the wild cat (*Felis guigna*), the gray fox (*Dusicyon griseus*), the puma (*Felis concolor*) and for the owl (*Bubo virginianus*) (Glade 1985; Valverde, 1988).

There are few data of the hematology (Vásquez *et al.*, 1992) and of the serum chemistry of deers in South America; specifically there is not for the pudu. However, several papers have been written on reproductive (Reyes *et al.*, 1987, 1993), behavior (Cortés *et al.*, 1988), and parasitism features (Fernández and Villalba, 1986). Blood and physiological values of captive and wild deer may differ, resulting from health status, stress, physiological state, drugs, nutrition, season of the year, sex and other factors. (Del Giudice *et al.*, 1990). Baseline physiological and hematological data of pudu are necessary to differentiate between normal and abnormal values and to generate capture procedures standardization.

KEY WORDS: *Pudu*, hematology.

PALABRAS CLAVE: *Pudu*, hematología.

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MATERIALS AND METHODS

ANIMALS

Seventeen specimens (9 males and 8 females), 1 to 10 years old of the Metropolitan Zoo of Santiago, Chile, were studied. Animals were maintained in three outdoor enclosures (6 x 9m) and they were fed with a high energy-protein commercial diet and water *ad libitum*. Each animal was eartagged, sexed, and weighed.

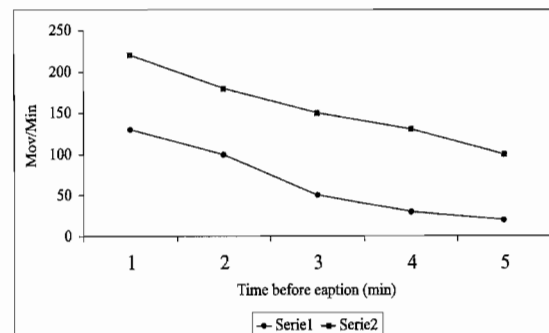
Physiological determination. Animals were confined individually in an outdoor enclosure (3x4m) for 24 hrs with water *ad libitum*. The measurements of physiological parameters such as body temperature, cardiac frequency, and respiratory frequency were obtained early in the morning (at 8:00 AM).

Cardiac frequency: Three electrodes (Mitchel hook) were located subcutaneously in the toraco/ventral area. A radio telemetric apparatus was fixed with Belcro^R on the back of each animal. The heart frequency was registered for 2 hr every 15 min. Respiratory frequency was measure in a period of 2 hours, with 15 min intervale (Fig 1).

Rectal temperature (Jumo Therm^R) was recorded 3 times, obtaining T₀, (8:00 AM); T₁, (9:00 AM) and T₂, (10:00 AM).

Figure 1

Effect of capture on cardiac and respiratory frequency on *Pudu pudu*



Two blood samples from the jugular vein were collected after stabilization of physiological parameters, (150 min after telemetric apparatus were fixed), using 5-cc. Vacutainer^R with heparin for chemistry and other 5-cc vials with EDTA^R (1-2 mg/dl) for hemogram, holding them in lateral decubitus. No sedatives were used. Plasma were obtained one hour after blood collection, hemogram and chemistry determination were analyzed within 4 hrs.

HEMATOLOGICAL PARAMETERS

Packed cell volume (PVC) was measured by microhematocrit capillary method by centrifugation for 3 minutes at 15,000 rpm. Colorimeter method were used to measure Hemoglobin concentration (Hb) using the cyanomethamoglobin method. Red blood cell (RBC) and white blood cell (WBC) counts were obtained using hemocytometer.

Differential white blood cell counts were performed on standard Giemsa stained blood films. Two hundred white blood cells were counted and classified in each sample. Mean corpuscular volume (MCV) and mean corpuscular hemoglobin concentration (MCHC) were calculated as described by Jain *et al.* (1986).

Serum chemistry plasma parameters were quantified using commercial test kits from different sources (Boehringer, Mannheim diagnostic, Merck, Darmstadt, Hycel, and Houston). The parameters were: total protein (TP g/dl), albumin (Alb g/dl), Globulin (Glob g/dl), Albumin/globulin ratio (A/G ratio), blood urea nitrogen (BUN mg/dl), glucose (Glu mg/dl). Aspartate aminotransferase (AST, E: C:2.6.1.1 U/L), Creatin kinase (CK, E:C: 2.7.3.2. U/L), Gamma Glutamyl Transferase, (GGT, E: C: 2.3.2.2. U/L) were quantified by UV, kinetic method 30°C. Fibrinogen were determined by refractometer (Jain *et al.* 1986). Only plasma without hemolysis were processed.

RESULTS AND DISCUSSION

Physiological, hematological and biochemical values of animals may vary according to geographic area, diet, health, and husbandry. Due to this fact, this study show values that are significant only in the condition that they was obtained.

Respiratory frequency was 124 inhale/min initially, decrease to 31 inhale/min at 45 min, and later to 26 - 28 inhale/min at 75 min post capture. The heart frequency at time 0 post capture was 214 +/- 28.7

beat/min; recovery time post capture was 150 min. with basal frequency of 102 +/- 11.3 beat/min (Fig.1). The mean corporal temperature was of 39.5 +/-0.15°C.

No data previously of physiological parameters were registered for this species, at this point. Nilsson *et al.* (1984) sustained that the elk (*Rangifer tarandus platyrhynchus* and *Rangifer tarandus tarandus*), shows higher heart frequency in summer.

The hematological and biochemical values for *P. pudu* are summarized in Table 1. Males and females were grouped together since no significant differences were observed between sexes for any parameter.

There was a considerable range in the values of some parameters such as BUN (18.9+/-12.2) and CK (201+/-194). Moreover, large range was observed too in some white blood cells, especially neutrophils (2678 +/-1796) and eosinophils (303+/-321).

The erythrocytes were fusiform with 2.5 to 5.1 μ in length and 1.0 to 2.1 μ wide, (Figure 2), similar to that described by Vásquez *et al* (1992) for the same specie and Upcott and Herbert (1967) in other cervids. Ellipse and triangular forms was observed

Table 1

HEMATOLOGY AND BLOOD CHEMISTRY IN CAPTIVE PUDU PUDU

	Mean	SE
Eritrocytes/10 ⁶ ul	11.23	2.9
PCV %	51.7	4.2
Hemoglobin (g/dl)	19.7	1.8
MCV (fl)	48.2	9.9
MCH (pg)	18.4	3.9
MCHC (g/dl)	38.2	1.5
White cell count/ul	7997	2 873
Band /ul	116	74.2
Neutrophils /ul	2 678	1 796
Lymphocytes/ul	4 715	1 281
Monocytes/ul	184	100
Eosinophils/ ul	303	105
Protein (g/dl)	8.7	1.01
Albumin (g/dl)	3.6	0.27
Globulin (g/dl)	4.7	1.21
Fibrinogen (g/dl)	0.4	0.12
AST (U/l)	94.8	29.9
CK (U/l)	201	194
GGT (U/l)	34.4	13.4
Urea (mmol/l)	6.7	4.3
Glucose (mmol/l)	5.7	1.5

n=17

PVC: packed cell volume; MCV: mean cell volume;

MCH: mean corpuscular hemoglobin;

MCHC: Mean cell hemoglobin concentration.

similar to those that Chapman (1977) described in *Muntiacus reevesi* and *Cervus duvauceli*. Probably different hemoglobin polymerization could explained these situation.

The erythrocytes parameters, red blood cell count, (RBC), hematocrit (HCT) and hemoglobin (Hb) were similar to those of red deer, *Cervus elaphus* (Cross *et al.*, 1988). These values were higher than those previously reported by Maede

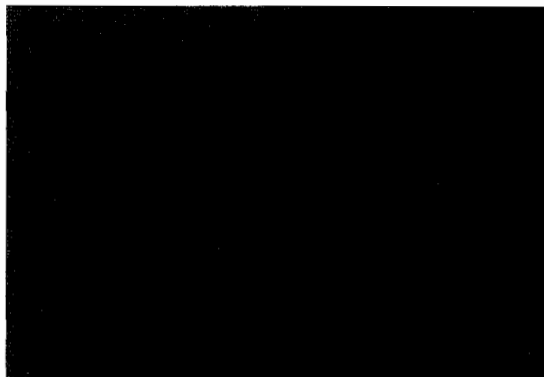


Figure 2. Eritrocytes of Pudu pudu (Giemsa, x 1000).

et al. (1990) for *Cervus nippon yesoensis* and for *Odocoileus hemionus* by Cowan and Bandy (1969), Anderson *et al.* (1970) and Seal *et al.* (1972).

The WBC was 7997 ± 2873 cells/ul, with lymphocyte predominance. The morphology of leucocytes was similar to describe for other mammalian. These parameters are similar to those reported previously by Clemens *et al.* (1987) for *Odocoileus virginianus*. The neutrophil show 3 to 5 segments (Fig. 3). The lymphocytes showed small size (2.5-3.6u), middle size (4.1 to 6.1 u) and large size (9.2-10.3u). N/L relation was 0.57/1. The monocytes were the largest cells; they present a size between 9.2 to 12.8 u diameter (Fig. 4). The trombocytes present azurophil granules and a size of 0.5 -1.0 u.

The total plasmatic protein observed was 8.7 ± 1.01 g/dl; albumin was 3.6 ± 0.27 , the fibrinogen was 0.4 ± 0.12 . They were similar to means reported for Chapman (1977) and Knox *et al.* (1988) for *Cervus elaphus* and *Cervus canadensis*.

The glucose (5.7 ± 1.5 mmol/l) was similar to reported by Chapman (1977). Bonacic and Macdonald (2003) showed that this parameter were significantly affected by transport after capture of *Vicugna vicugna*.

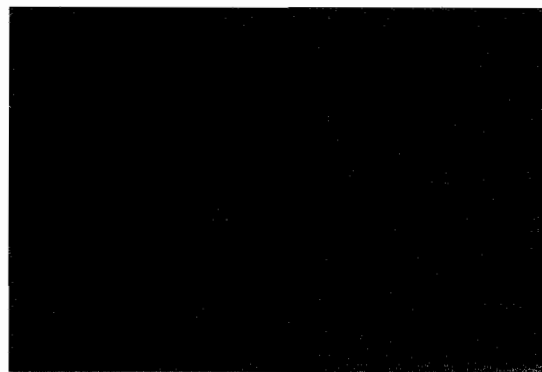


Fig 3. Neutrophil of Pudu pudu (Giemsa, x 1000).



Figure 4. Monocytes of Pudu pudu (Giemsa, x 1000).

The urea formation depends on the rate amino acid catabolism, in these study urea show; a wide range of 6.7 ± 4.3 mmol/l was observed but no data were signed previously in the literature.

The AST activity was 94.8 ± 29.9 UL; it's necessary to considered the distinct tissues of origin of this enzyme.

The CK activity was 201 ± 194 UL; that express the muscle activity.

The GGT activity was 34 ± 13.4 UL. was similar to the ovine and cows.

REFERENCES

- ANDERSON, A.; MEDIN, D.; BOWDEN, D. 1970. Erythrocytes and leukocytes in Colorado mule Deer population. J. Wild. Manage. 34 (2): 389-406.
- BONACIC, C.; MACDONALD, D. 2003. The physiological impact of wool-harvesting procedures in vicuñas (*Vicugna vicugna*). Animal Welfare. 12:387-402.
- CLEMENS, E.; MEYER, K.; CARLSON, M.; SCHNEIDER, N. 1987. Hematology, blood chemistry and selenium values of

- captative Pronghorn Antelope, White-tailed Deer and American Bison. Comp. Biochem. Physiol. 87C (1):167-170.
- COWAN, I.; BANDY, P. 1969. Observations on hematology of several races of Black-tailed Deer (*Odocoileus Hemionus*). Can. J. Zool. 47:1021-1024.
- CORTÉS, R.; ANGULO, A.; GUZMÁN, R.; REYES, E. 1988. Comportamiento del Pudú (*Pudu pudu*) en cautiverio. Gayana Zool. 52:3-14.
- CROSS, J.; MACKINTOSH, C.; GRIFFIN, J. 1988. Effect of physical restraint and xylazine sedation on hematological values in red deer (*Cervus elaphus*). Res. Vet. Sci. 45:281-286.
- CHAPMAN, D. I. 1977. Comparative Clinical hematology. Archer R. and Jeffcott, L. Eds. Blackwell Sc Pub, Oxford.
- DEL GIUDICE, G.; MECH, L.; SEAL, U. 1990. Effects of winter fasting and refeeding on White-tailed Deer blood profiles. J. Wild. Manage. 51:865-873.
- FERNÁNDEZ, J.; VILLALBA, C. 1986. Presencia de *Linguatula serrata* en ciervo chileno *Pudu pudu*. Parasitol, al día 10:29-30.
- GLADE, A. 1985. El pudú, un silencioso habitante de nuestros bosques. Fauna 11. Corp. Nac. Forestal Chile.
- HERSHK OWITZ, P. 1982. Neotropical deer (cervidae) Pudus, genus *Pudu* Gray. Fieldiana Zool. 11:11-86.
- JAIN, N. 1986. Schalm Veterinary Hematology. Lea and Febiger Ed. Philadel. USA.
- KNOX, D.; MC KELVEY, W.; JONES, A. 1988. Blood biochemical references values for farmer Red Deer. Vet. Rec. 122:109-112.
- MAEDE, Y.; YAMANAKA, Y.; SASAKI, A.; SUZUKI, M.; OHTAISHI, N. 1990. Hematology in Sika deer (*Cervus Nippon yesoensis*) JPN. J. Vet. Sci. 52:35-41.
- NILSSEN, K.; JOHNSEN, H.; GOGNMO, A.; SCHYTTE, A. 1984. Heart rate and energy expenditure in resting and running Svalbard and Norwegian Reindeer. Am. J. Physiol. 246:963-967.
- REYES, E.; DONOSO, J.; GUZMÁN, R.; RAMÍREZ, I. 1987. Cambios estacionales en espermioogénesis del *Pudu pudu*. Arch. Biol. Med. Exp. 20:242.
- REYES, E.; MUÑOZ, P.; RECABARREN, S.; TORRES, P.; BUBENICK, G. 1993. Seasonal variation of LH and testosterone in smallest deer, the pudu (*Pudu pudu*, Molina) and its relationship to the antler cycle. Comp. Biochem. and Physiol. 106 A:683-685.
- SEAL, U.; OZAGA, J.; ERICKSON, A.; VERME, L. 1972. Effects of immobilizations on blood analyses of White-tailed Deer. J. Wild. Manage. 36:1034-1040.
- STUTZIN, M. 1992. Informe sobre captura, comercio y tenencia en cautiverio de *Pudu pudu* en Chile. Alerta Traffic Sudamérica. 2:9-16.
- TAMAYO, M. and FRANSSINETTE, D. 1982. Catálogo de mamíferos fósiles y vivientes de Chile. Bol. Mus. Nac. Hist. Nat. Chile. 37:323-399.
- UPTCOTT, D. and HERBERT, C. 1967. Some hematological data for Red Deer *Cervus elaphus*, in England. Vet. Rec. 77: 1348-1349.
- VÁSQUEZ, A.; CATTANEO, G.; MONTES, G.; FLORES, E.; RIVEROS, V.; IBARRA, L. 1992. Descripción morfológica del eritrocito del *Pudu pudu* (Molina, 1782). Rev. Chile. Anatomía. 10:54.