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Author(s): Pablo E. Martino, D.V.M., M.S., Sandra M. Aráuz, D.V.M., Fernando Anselmino, D.V.M., Cecilia C. Cisterna, D.V.M., Maria P. Silvestrini, D.V.M., Santiago Corva, D.V.M., and Federico A. Hozbor, D.V.M.

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HEMATOLOGY AND SERUM BIOCHEMISTRY OF FREE-RANGING NUTRIA (*MYOCASTOR COYPUS*)

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Abstract: Information on reference blood values in the literature is lacking for many wild rodents. In this study, comprehensive reference intervals (RIs) for a wide range of analytes from 101 healthy free-ranging nutria were determined. Animals were captured in Buenos Aires, Argentina (37°50′S, 57°34′W), and southward (38°60′S, 58°23′W), encompassing major biotopes of agricultural pampas with dunes and grassland steppes on the east coast. Traps were set at locations with high-density nutria populations (i.e., those areas that showed signs of movement, territorial marking, or feeding activities). Although the small sample size limits the interpretation of these findings, RIs were determined by a robust method using the central 95th percentile. In nutria, the RI range varied greatly for the leukocyte differentials, with mature neutrophils: 3,907–5,544/μl for females and 3,744–5,900/μl for males; band neutrophils: 0–10/μl for females and 3–18/μl for males; lymphocytes: 4,213–5,940/μl for both sexes combined; monocytes: 165–402/μl for both sexes combined; eosinophils: 13–91/μl for females and 108–165/μl for males; and basophils: 0–87/μl for both sexes combined. Platelet concentration was 543–727 $\times$ 10^9/L for both sexes combined. There was also a wide RI range for biochemistry values for some enzymes, such as alkaline phosphatase: 200–399 IU/L for both sexes combined; cholinesterase: 762–1,407 IU/L for females and 763–1,284 IU/L for males; creatine kinase: 182–552 IU/L for females and 162–451 IU/L for males; amylase: 853–1,865 IU/L for females and 779–1,293 IU/L for males; and glucose concentration 120.2–180.6 mg/dl for both sexes combined. Conversely, there was not a wide pooled RI range for calcium: 7.0–11.2 mg/dl; phosphorous: 6.1–9.3 mg/dl; sodium: 133.0–159.0 mEq/L; potassium: 3.0–8.2 mEq/L; chloride: 101.4–143.0 mEq/L; and urea: 11.3–36.8 mg/dl. The red blood cell indices had a narrow range, with mean corpuscular volume: 84.0 –102.5 fl and mean corpuscular hemoglobin concentration: 18.2–28.8 g/dl, and which was most likely due to strict physiologic controls. The results from this study were similar to those previously reported for farmed nutria.

Key words: Hematology, *Myocastor coypus*, nutria, serum biochemistry.

INTRODUCTION

The nutria, or coypus (*Myocastor coypus*), is a semiaquatic rodent native to South America that was introduced to many countries for meat production and fur farming.[13] In 1922, Argentinians began raising the species in captivity.[19] In its native range of Argentina, the nutria is commercially the most important wild mammal in the fur market and is a major source of income for local people. Free-ranging nutria are hunted yearly and represent approximately 70% of all fur exported from Argentina in the last decade. According to the International Union for Conservation of Nature Red List, the species is currently listed as lower risk/least concern and, as such, is not threatened.[9]

Although farmed nutria have been the subject of hematologic and biochemical studies, hematologic measurements for free-living nutria are scarce in the literature.[1,2] Blood analyses may be used to assess the health and physiologic condition of free-living animals and may indicate nutrition, disease, trauma, and environmental stressors; however, baseline ranges of these analytes must be established before such data can be interpreted and applied. Reference intervals (RIs) are used to describe the dispersion of reference values in healthy individuals, and they usually represent the central 95% of the healthy population.[7] The purpose of this study was to determine the RIs of hematologic and biochemical values of free-living nutria.

MATERIAL AND METHODS

Sampling was conducted between April 2004 and November 2006. A total of 101 adult coypus (54 females and 47 males) from Buenos Aires

From the Department of Pathology and Microbiology-Provincial Research Council (CIC) (Martino), the Department of Hematology (Aráuz, Anselmino), and the Department of Statistics (Silvestrini, Corva), Veterinary College, La Plata University, 60 y 118, P.O. Box 296, B1900AVW La Plata, Argentina; the Pathobiology Department, National Institute of Technology, Los Reseros y Las Cabañas, P.O. Box 77, 1708 Morón, Argentina (Cisterna); and the Animal Production Unit, National Institute of Technology, P.O. Box 276, 7620 Balcarce, Argentina (Hozbor). Correspondence should be directed to Dr. Martino (pemartino@fcv.unlp.edu.ar).

Province, east central Argentina (37°50′S, 57°34′W and 38°60′S, 58 °23′W) were captured throughout the year with nets and homemade padded box traps constructed with a spring-lock mechanism designed not to harm the animals. This study was performed in compliance with current regulations for the protection of vertebrate animals used for experimental purposes.[3] The majority of the nutria were trapped as part of other studies (i.e., serologic and parasitologic surveys). This project was approved by the Animal Care Committee of the Research Scientific Council (CIC, decree No.578/04), and the protocol for handling nutria was approved by the Agrarian Resources Ministry (approval No. 22230–27/2006-0). After capture, each nutria was manually restrained and then transported to a special restraint box (Tomahawk Bailey Beaver Trap, Model 801, Tomahawk Live Trap Co., Tomahawk, Wisconsin 54487, USA) during a <60-min handling period. The sex, approximate age, and reproductive status were determined as previously described.[24] Approximately 10 ml of fresh venous blood was collected by lateral saphenous or caudal tail venipuncture with a 20-gauge needle (syringe 20G, Becton, Dickinson Co., Rutherford, New Jersey 07147, USA) into vacuum tubes, 5 ml in an ethylenediamine-tetra-acetic acid-treated tube and 5 ml in a sterile tube containing no anticoagulant (Vacutainer™ tubes, Becton, Dickinson Co., Rutherford, New Jersey 07147, USA). Captured animals were ear tagged (flexible size 3 ear tag, Leader Products, Craigieburn, Victoria 3064, Australia) and then released.

After 1 hr, to allow for maximum clot retraction, serum and cell fractions were separated at 1,800 *g* for 10 min, and then the serum was transferred to clean tubes (10-ml precapped serum transport tube with red cap, Capitol Vial, Inc., Auburn, Alabama 36832, USA) using 5-ml plastic transfer pipets (Globe Scientific, Inc., Paramus, New Jersey 07652, USA). The serum and whole blood were stored at 4°C and analyzed the same day.

All analytical procedures for hematology and biochemistry[12,21] and the description of the automated analyzers are summarized in Table 1. Instrument performance, calibration, and quality control results were systematically reviewed on a regular schedule according to recommended guidelines for automated methods.[23]

Biologic variability of some hematologic and biochemistry components in nutria with automated methods (CV%, coefficient of variation) was estimated from within-run studies on duplicates of 20 separate samples or based on 10 samples in duplicate in two batches on the same day.

The following hematologic measures were calculated: hematocrit (HCT), hemoglobin (Hb), red blood cells (RBCs), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), white blood cells (WBCs), leukocyte differential concentration (neutrophil, lymphocyte, monocyte, eosinophil, and basophil), platelets, reticulocytes, and Heinz bodies and circulating nucleated red blood cells (NRBCs). Serum chemistries measured include uric acid, blood urea nitrogen (BUN), glucose, creatinine, total protein, albumin, aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), cholinesterase (CE), creatine kinase (CK), amylase, cholesterol, bilirubin, calcium (Ca), phosphorous (P), sodium (Na), potassium (K), and chloride (Cl).

Wedge-type blood smears were prepared and stained with Wright's stain (Wright Stain Solution TR26060-05, Electron Microscopy Sciences, Hatfield, Pennsylvania 19440, USA) for determination of leukocyte differential count and RBC morphology. For the reticulocyte count, two drops of EDTA anticoagulated blood (Potassium-EDTA, Sarstedt AG & Co., Rommelsdorfer Strasse, Postfach, 1220, 51582 Nümbrecht, Germany) were incubated with an equal volume of new methylene blue stain (VMB-030, Volu-Sol's New Methylene Blue, Volu-Sol Inc., South Salt Lake City, Utah 84120, USA) for 15 min, and wedge-type blood smears were made. Heinz body slides were prepared by staining with brilliant green stain (TB brilliant green, Alpha-Tec Systems, Inc., Vancouver, Washington 98682, USA). Reticulocytes and Heinz bodies were enumerated as the percent of 1,000 RBCs counted. NRBCs were detected on examination of the routinely prepared smears and enumerated as per 100 WBCs. Platelets were considered adequate based on morphology by examination of smears and when volume distribution approached log normality according to the figures taken from previous studies.[2,22]

Basic statistics, including means, medians, and RIs, were calculated. The Shapiro-Wilk normality test was performed. RIs were calculated with GraphPad Prism software (GraphPad Software, La Jolla, California 92037, USA) using the robust method advocated by the CLSI C28-A3 Guideline.[4] Outliers were eliminated by use of Tukey's method, which defines outliers as three interquartile ranges below the 25th percentile or above the

Table 1. Analytical procedures for hematology and biochemistry and automated analyzer description.[a]

Analyte	Method of analysis	Apparatus
Hematology		
RBCs	By an electronic counting device	Coulter Counter Model S-Plus analyzer[b]
WBCs	By an electronic counting device	Coulter Counter Model S-Plus analyzer[b]
Platelets	By an electronic counting device	Coulter Counter Model S-Plus analyzer[b]
HCT	By an electronic counting device	Coulter Counter Model S-Plus analyzer[b]
Hb	By an electronic counting device	Coulter Counter Model S-Plus analyzer[b]
MCV	By an electronic counting device	Coulter Counter Model S-Plus analyzer[b]
MCH	By an electronic counting device	Coulter Counter Model S-Plus analyzer[b]
MCHC	By an electronic counting device	Coulter Counter Model S-Plus analyzer[b]
Biochemistry		
Uric acid	Kinetic uricase method	Abbott Spectrum series II analyzer[c]
BUN	Full enzymatic method (urease)	Abbott Spectrum series II analyzer[c]
Glucose	GOD-PAP method	Abbott Spectrum series II analyzer[c]
Creatinine	Kinetic Jaffe reaction	Abbott Spectrum series II analyzer[c]
Total protein	Biuret method	Abbott Spectrum series II analyzer[c]
Albumin	Dye-binding (Bromo Cresol green) technique	Abbott Spectrum series II analyzer[c]
Cholesterol	CHOD-PAP method	Abbott Spectrum series II analyzer[c]
Billirubin	Time endpoint Diazo method	Abbott Spectrum series II analyzer[c]
Ca	CPC method	Abbott Spectrum series II analyzer[c]
P	Molybdenum blue reaction	Abbott Spectrum series II analyzer[c]
Na	Galactosidase enzymatic method	
K	Pyruvate kinase enzymatic method	Abbott Spectrum series II analyzer[c]
Cl	Mercuric thiocyanate method	Abbott Spectrum series II analyzer[c]
CE	Cholinesterase Gen.2	Automated chemistry analyzer[d]
ALT	UV-test, ALT IFCC phosphate activation	Automated chemistry analyzer[d]
AST	UV-test, AST IFCC	Automated chemistry analyzer[d]
ALP	Colorimetric assay, ALP optimized	Automated chemistry analyzer[d]
CK	UV-test, CK IFCC	Automated chemistry analyzer[d]

[a] RBCs, red blood cells; WBCs, white blood cells; HCT, hematocrit; Hb, hemoglobin; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin; MCHC, mean corpuscular hemoglobin concentration; BUN, blood urea nitrogen; GOD-PAP, glucose oxidase-peroxidase; CHOD-PAP, cholesterol-oxidase-phenol aminophenazone; Ca, calcium; CPC, cresolphtalein complexone; P, phosphorous; Na, sodium; K, potassium; Cl, chloride; CE, cholinesterase; ALT, alanine aminotransferase; UV, ultraviolet; AST, aspartate aminotransferase; ALP, alkaline phosphatase; CK, creatine kinase.

[b] Counter Electronics, Hialeah, Florida 32821, USA.

[c] Abbott Laboratories, Abbott Park, Illinois 60064, USA.

[d] CX4, Beckman Instruments, Brea, California 92835, USA.

75th percentile.[19] For the purpose of identifying subgroups by sex requiring separate RIs, analytical estimation was performed as described previously.[6] Briefly, for each variable, distributions were assessed with medians and interquartile ranges (75th percentile minus 25th percentile), and the following rules were defined: 1) if the difference between the medians of each compared subgroup was <50% and the difference between the interquartile intervals of each compared subgroup was <100%, subgroups were pooled; 2) if the difference between the medians of each compared subgroup was between 50% and 100% but the difference between the interquartile intervals of each compared subgroup was <50%, subgroups were also pooled; 3) otherwise, subgroups were analyzed separately.

RESULTS

The individuals were apparently healthy at the time of blood collection. Some of them were excitable and restraint added to their agitation, but severe postcapture stress signs (e.g., a consistent lack of aggression, no vocalization, weakness, or death) were not observed. Full hematologic and biochemical profiles were completed on 91 adult animals (49 females and 42 males), after discarding 4 cases due to insufficient blood volume or evidence of hemolysis and 6 cases with extreme values. Several true outliers were detected mostly among the biochemical analytes (i.e., creatinine, albumin, bilirubin, Ca, P, ALP, and CE) but also among the hematologic variables (i.e., MCHC, eosinophils, and basophils). These results were removed from calculations of RIs,

Table 2. Hematologic values for 91 healthy free-ranging adult nutria.[a]

Variable	Class	*n*	Mean (SD)[b]	Median	RI[c]
HCT (%)	Pool	91	43.0 (1.4)	43.5	39.3–45.1
Hb (g/dl)	Pool	91	9.6 (0.75)	9.4	8.0–11.4
RBCs (10^6/µl)	Pool	91	4.5 (3.6)	4.4	3.9–6.0
MCV (fl)	Pool	91	96.8 (2.1)	98.9	84.0–102.5
MCH (pg)	Pool	91	21.0 (1.3)	21.4	18.2–23.4
MCHC (g/dl)	Pool	91	20.5 (2.3)	20.4	18.2–28.8
WBCs (10^3/µl)	Females	49	11.0 (1.8)	10.5	9.9–12.9
	Males	42	12.1 (0.5)	12.1	11.0–13.1
Leukocyte differential concentration					
Mature neutrophils[d]	Females	49	4,544 (367.3)	4,298	3,907–5,544
	Males	42	5,056 (341.8)	5,037	3,744–5,900
Band neutrophils[d]	Females	49	5 (3.2)	6	0–10
	Males	42	11 (4.5)	13	3–18
Lymphocytes[d]	Pool	91	5,191 (300.4)	5144	4,213–5,940
Monocytes[d]	Pool	91	239 (68.1)	216	165–402
Eosinophils[d]	Females	49	32 (18.6)	29	13–91
	Males	42	141 (15.8)	146	108–165
Basophils[d]	Pool	91	0 (1.54)	0	0–87
Platelets (10^9/L)	Pool	91	626 (41.1)	623	543–727
Reticulocytes (10^3/µl)	Pool	91	14.4 (0.6)	14.2	0–189
Reticulocytes (%)			0.3	0	0–3.9
Heinz bodies (%)[e]	Pool	91	0 (0.1)	0	0–0.2
Nucleated RBCs[f]	Pool	91	0 (0.1)	0	0–10

[a] SD, standard deviation; RI, reference interval; HCT, hematocrit; Hb, hemoglobin; RBCs, red blood cells; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin; MCHC, mean corpuscular hemoglobin concentration; WBCs, white blood cells.
[b] Standard deviation.
[c] Medical Reference Intervals calculated with robust analysis using the central 95th percentile.
[d] Absolute value per µl.
[e] Percent of 1,000 red blood cells counted.
[f] Per 100 white blood cells. Nucleated red blood cells were seen on re-examination in 39 of the routinely prepared smears.

and all data from those animals were deleted from the dataset. The median value and the RIs of the hematologic and serum biochemistry profiles for the 91 nutria, combined or partitioned by sex, are summarized in Tables 2 and 3. Significant increased values of WBCs, mature neutrophils, band neutrophils, and eosinophils and decreased values of ALT, CE, CK, amylase, and bilirubin were found in the male subgroup when compared with the female subgroup, and therefore these RIs were partitioned.

Platelet numbers were adequate in the bulk of the samples, but the presence of clumps, very large platelets, or other morphologic flags were recorded in five cases. In addition, no qualitative RBC abnormalities were noted. Basophils were only seen in samples from females, although in small numbers.

Biologic variability of some hematologic and biochemistry components ranged from 0.4% for HCT to 5.4% for glucose. Quality control of the automated analyzer resulted in a CV of 3.8% for WBC counts. Meanwhile, the CVs of the differential cell counts ranged from 1.4% (band neutrophils) to a maximum of 3.1% (monocytes). The repeatability of measurements made was low for the rest of the analytes studied (<2%).

DISCUSSION

Nutria fur was in such high demand and the animal hunted so avidly that nutria became rare and had to be protected by government decree two decades ago.[20] Nutria are still affected by overhunting, loss of habitat, droughts, and predation by carnivores, which have reduced their number and range.[14]

The goals of this study were to develop comprehensive RIs for hematologic and biochemical analytes using central 95th percentile robust analyses. Differences in median and interquartile intervals were considered to be adequate to determine partitioned RIs by sex in 9 of the 35 variables. According to international recommendations, RIs should be determined from at least

Table 3. Serum biochemistry values for 91 healthy free-ranging adult nutria.[a]

Variable	Class	*n*	Mean (SD)	Median	RI[b]
Uric acid (mg/dl)	Pool	91	2.2 (0.6)	2.3	2.0–3.6
BUN (mg/dl)	Pool	91	23.8 (3.5)	24.6	11.3–36.8
Glucose (mg/dl)	Pool	91	160.9 (10.9)	162.2	120.2–180.6
Creatinine (mg/dl)	Pool	91	1.3 (0.9)	1.2	0.6–5.8
Total protein (g/dl)	Pool	91	7.6 (1.0)	7.5	6.3–8.9
Albumin (g/dl)	Pool	91	4.3 (1.2)	4.2	3.0–6.1
AST (IU/L)	Pool	91	139 (11.2)	141	118–177
ALT (IU/L)	Females	49	125 (11.8)	122	103–166
	Males	42	119 (6.6)	119	108–142
ALP (IU/L)	Pool	91	289 (41.6)	295	200–399
CE (IU/L)	Females	49	999 (131.8)	1,113	762–1,407
	Males	42	964 (92.49)	953	763–1,284
CK (IU/L)	Females	49	426 (76.32)	492	182–552
	Males	42	198 (53.04)	185	162–451
Amylase (IU/L)	Females	49	1,221 (228.6)	1,320	853–1,865
	Males	42	1,014 (92.38)	1,016	779–1,293
Cholesterol (mg/dl)	Pool	91	75.1 (9.3)	76.7	34.1–9.3
Bilirubin (mg/dl)	Females	49	1.2 (0.4)	1.1	0.3–2.0
	Males	42	1.2 (0.9)	1.0	0.5–5.9
Ca (mg/dl)	Pool	91	10.0 (1.4)	10.2	7.0–11.2
P (mg/dl)	Pool	91	7.7 (0.9)	7.9	6.1–9.3
Na (mEq/L)	Pool	91	144.8 (5.9)	143.9	133.0–159.0
K (mEq/L)	Pool	91	5.5 (1.0)	5.4	3.0–8.2
Cl (mEq/L)	Pool	91	123.4 (8.5)	121.8	101.4–143.0

[a] SD, standard deviation; RI, reference interval; BUN, blood urea nitrogen; AST, aspartate aminotransferase; ALT, alanine aminotransferase; ALP, alkaline phosphatase; CE, cholinesterase; CK, creatine kinase; Ca, calcium; P, phosphorous; Na, sodium; K, potassium; Cl, chloride.

[b] Medical RIs calculated with robust analysis using the central 95th percentile.

120 reference individuals, which often are impossible to achieve in veterinary clinical pathology, especially for wild animals.[7] When only a small number of reference subjects is available, then alternate statistical approaches, such as the robust method, make it possible to establish RIs using smaller reference sample sizes.[4] Thus, the number of RIs presumed healthy in this sample population is considered adequate, and considerably higher than in many exotic species, for the establishment of RIs on nutria. However, it is possible that the definition of a clinically healthy animal did not exclude all unhealthy nutria.

Because hemolysis can influence several parameters (i.e., AST, CK, K, P, creatinine, bilirubin, and total protein),[1,2,18] serum hematology and biochemistry values were not assessed in hemolyzed samples.

There has been much debate in the literature regarding what to do with extreme or influential data points. Given that outliers may serve to increase error variance and reduce the power of statistical tests, those detected here were removed from RI calculations.

RI determination can be difficult in wild species because the stress and physiologic effects of handling can affect the results of laboratory tests and can potentially lead to erroneous interpretations.[1] Although excitability during the capture may have influenced the results in this survey, this would be the case in any situation of blood collection from free-living animals and, therefore, may actually represent a norm with an appropriate population. Several indicators of stress noted in other free-living animal studies (i.e., WBC, glucose, Na, AST, and CK elevation) were not evidently affected by capture method or pursuit intensity in the nutria of this study.[18]

Due to the small number of animals sampled, RIs calculated in this manner were judged to be wide for a number of analytes. This was especially true with the hematologic data (i.e., leukocyte differentials and platelet concentrations).

Conversely, the RBC indices showed moderate or narrow intervals. It is well known that analytes, such as leukocyte counts and WBC differentials, commonly show greater biologic and analytical variation. Frequently, free-ranging wildlife spe-

cies increase peripheral eosinophil counts secondary to an increased parasitic burden. Meanwhile, stress induces corticosteroid or epinephrine release and alterations in the WBC count and white cell differential.[4] RIs for WBCs concentration may be subjected to biologic variation (i.e., between-nutria and within-nutria variation), and the estimate of these components of variance can be useful to assess the critical difference for significance between serial results, before reaching a definitive conclusion on moderate values outside of the RIs.

The repeatability of measurements made was remarkably low for the bulk of the analytes studied. Therefore, taking into account the few differences recorded, this material was considered homogeneous and adequate for the study to be conducted. The within-individuals variance is due to environmental causes, whereas the among-individuals variance is partly environmental and partly genetically determined.[15] Considerable variation is detailed in the literature regarding the concentrations of neutrophils and lymphocytes in farm-bred nutria.[10] Herein, basophils were seen solely in females. Meanwhile, some authors observed them in farm-bred nutria of both sexes with similar numbers (from 0.4% to 1.7%).[7,22]

Baseline characteristics of RIs have not been published for the free-living nutria, and comparisons are usually made with data obtained from the farm-raised animals.[1,2]

Regrettably, all previous reports of nutria expressed their results only with mean or median values. The values obtained in this study for many of the hematologic measurements were generally similar to those previously detailed for European farm-raised nutria, with the exception of WBC, HCT, and Hb concentrations, which were slightly higher, although not statistically significant, than those previously reported.[2,7,10,16,17] The lower values obtained in other studies may be due to the administration of sedatives or anesthetics to animals or as a result of different laboratory methodologies used for the assays.[1] In fact, venipuncture without sedation may result in higher hematologic profiles in many animal species due to stress and splenic contraction.[21] On the other hand, MCH and MCHC values were lower than those described.[10] Perhaps some of the differences with the concentrations already reported are related to the diverse environmental conditions, parasitism, and diet, or, simply, the analytical approach may have caused such variation.[2,5,8,11,22]

Likewise, a similar platelet concentration has been previously described in normal nutria.[2,22] Platelet morphology was adequate in the majority of the examined samples. In addition to the analytes (i.e., platelet count) that were determined via automated analyzers, microscopic examination of the blood film for platelet morphology and evidence of clumping or adherence to leukocytes is recommended. Even if the platelet count is normal, direct examination can disclose abnormal platelet function or coagulopathy.

To our knowledge, this is the first study that details the presence of Heinz bodies and NRBCs in nutria. Heinz bodies are aggregates of denatured, precipitated hemoglobin within RBCs.[1] Here, Heinz bodies were present in $<1\%$ of the RBCs. It is unknown if nutria have an increased incidence of Heinz bodies relative to other species due to both increased formation and decreased removal. NRBCs were identified in less than a half of the peripheral blood smears, in few numbers, and in a narrow numerical range. They can be seen in the peripheral blood of some furbearing animals, in particular those of the marten family, under pathologic situations (i.e., regenerative anemia and bone marrow injury), but they are also a normal finding in other animals (i.e., alpacas or some dog breeds).[1,2,12] These hematologic aspects are generally poorly understood in furbearing animals, and based on the findings of this current study, further studies are needed.

On the other hand, reticulocytes were reported in farmed nutria with a value of 0.9 $10^3/\mu l$, which was lower than was determined in this current study of free-living nutria.[2] Normally, only about 1% of all RBCs in the bloodstream of the majority of domestic animals are reticulocytes.[1] In the face of establishing anemia in furbearing animals, any reticulocyte response less than two to three times the normal amount, depending on the hematocrit level, indicates an inadequate marrow response.[2] Again, further quantitative studies are needed to explain this observed difference.

Regarding the biochemistry values obtained, current data were commonly skewed, including glucose, cholesterol, and Cl. Moreover, analytes, primarily ALP, CE, CK, amylase, and glucose, had wide RIs. Glucose concentration is readily altered with stress and excitement due to catecholamine release.[2] Ca, P, Na, K, Cl, and BUN had narrow RIs, probably related to physiologic control mechanisms.

Reports of serum biochemistry data for nutria are very limited, and the present ranges are

generally similar to those reported for free-ranging nutria from Louisiana[11] and for European-farmed nutria.[22] The comparison between those previous surveys and the present study must be made with caution, because the instrument and methods information for biochemistry analyses are minimally reported. Progress in the design of laboratory instrumentation has made it possible to replace the labor-intensive manual performance of the majority of these tests with highly automated assays having smaller CVs.

Concentrations of albumin and P along with ALP activity were found slightly higher than those previously described. Meanwhile, uric acid concentration and AST activity were lower.[10,17] Data for BUN, Na, K, and Cl concentrations and for ALT, CE, CK, and amylase activities are reported for the first time in nutria.

The median value for ALP activity was higher than that determined for wild nutria[17] and for farm-animals.[10] Again, some diversity could be attributable to diet, stress, innate fluctuations in domestic and wild animals, or laboratory variation.[1,12]

The total CE activity of the blood serum has been investigated in most of the furbearing animals, such as mink and foxes, and age and seasonal variations have been reported.[2,20] Values for nutria appear higher than in those carnivores, and this variation may be due to different methods used for assessing the CE absolute activity or to intrinsic species factors.

Serum CK and AST activity could be critical in nutria, as in other free-living animals, because they may be increased due to muscle or soft-tissue injury during the capture process.[8,12] In this study, AST activity of the blood serum was higher than the ALT activity. This difference has been observed in most furbearing animals.[1,2] Separate RIs for gender class were created for CK and ALT, because the statistical difference noted might mean biologic or clinical significance.

Because a uniform capture and sampling protocol was utilized without the use of anesthetic agents and preanalytic variability was further minimized by prompt submission of samples to a single laboratory for complete hematologic and biochemical profiles, the data presented may contribute to the continued evaluation of the status of this species in the wild and may be valid to other nutria populations across a wide geographic range.

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