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BLOOD CHEMISTRY OF THE WEST INDIAN MANATEE *(TRICHECHUS MANATUS)* [L]

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Abstract: Blood from 10 clinically healthy West Indian manatees (8 wild, 2 captive) was analyzed for the common blood chemical substances. No sex differences were found. The results were comparable for the most part to those of the common domestic mammals. Notable exceptions were the anion gaps, and total proteins and A/G ratios which were higher than those for domestic species. Some of these differences were no doubt due to the stress of capture.

INTRODUCTION

The sirenians are a group of aquatic herbivorous mammals whose blood chemistry, has been largely neglected by biologists. There have been some isolated studies on a few animals of the blood composition and properties (Farmer et al., 1979), red cell enzymic complement (White et al., 1976), bladder bile composition (Caldwell et al., 1969), composition of milk (Bachman and Irvine, 1979), and changes occurring during diving exercises (Scholander and Irving, 1941).

The study reported here deals with the analysis of blood from clinically healthy West Indian manatees during the winter of 1979-80. These studies will help to establish a comparative base for future studies, perhaps diseases of captive or stranded animals. Since manatees are now endangered and protected, it behooves us to know as much as possible about their biology and how they are expected to respond to various stresses imposed upon them by man's encroachment on their habitat. It is hoped also that the information obtained will aid in the management of the species.

MATERIALS AND METHODS

Blood was obtained from 10 animals during the winter of 1979-80 in Florida. The group consisted of three females and seven males. Eight of the animals were wild, wintering at Blue Spring Run, Volusia County. Two of the animals were captive, and five of the animals were sexually immature (Table 1). Other biological data on these animals have been reported (Medway and Black, 1981; Medway et al., 1981).

Blood was collected from a vascular bundle near the plantar surface of the pectoral limb. The peripheral vasculature of the pectoral limb is unique in sirenians in that the brachial and axillary arteries divide abruptly into hundreds of arterioles of equal caliber (Fawcett, 1942). Each arteriole is accompanied by two venules to constitute a vascular bundle. It was one of these vascular bundle(s) that was penetrated by the needle when obtaining blood. The blood was then placed into clean tubes and allowed to clot and refrigerated. Within 24 h the samples were centrifuged, the serum was separated and frozen until analyzed.

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TABLE 1. Some chemical constituents in blood from 10 manatees.

Animal #	Sex	Length (cm)	Gluc mg/dl	BUN mg/dl	Creat mg/dl	Fe μg/dl	TIBC μg/dl	% Sat IBC	TP g/dl	Alb g/dl	Glob g/dl	A/G
1	M	315	95	17	1.5	160	384	41	8.2	5.1	3.1	1.6
2[a]	F	309	105	21	1.5	105	362	29	8.5	5.2	3.3	1.6
3[b]	F	317	45	12	1.6	107	350	31	8.2	4.8	3.4	1.4
4[c]	M	241	62	10	1.8	115	323	36	8.1	5.0	3.1	1.6
5	M	287	85	17	1.8	131	400	33	8.7	5.1	3.6	1.4
6[c]	M	219	72	12	1.5	50	309	16	8.3	5.0	3.3	1.5
7	M	263	96	10	1.9	143	339	42	8.3	4.8	3.6	1.3
8	M	266	120	13	3.0	137	411	33	8.9	5.3	3.4	1.5
9[d]	M	275	37	20	0.8	115	399	29	7.7	4.3	3.9	1.3
10[c,d]	F	247	115	10	0.9	87	304	29	7.8	3.9	3.9	1.0
Mean			83	14.2	1.63	115	359	32	8.27	4.85	3.43	1.42
Std Dev			29	4	0.6	31	40	7.3	0.4	0.4	0.3	0.2

[a]Pregnant
[b]Lactating
[c]Sexually immature animals <275 cm (G.B. Rathbun, pers. comm.)
[d]Captive animals — Sea World of Florida, Orlando

The methodology of the Gemsaec [5] autoanalyzer was used to determine the Aspartate transaminase (AST) (formerly GOT) and Alanine transaminase (ALT) (formerly GPT). The K and Na were determined by flame photometry. The remainder of the constituents were determined utilizing the SMA 12/60 autoanalyzer [6] and the Gemini autoanalyzer [7] and their respective methodologies. The anion gaps were calculated. The osmolality was obtained with an Osmette A. [8]

RESULTS

The results of the chemical analyses are presented in Tables 1, 2 and 3.

Table 1 shows the results obtained on analysis of blood for the commonly measured constituents that are used to assess the health status of an animal. The results, with a few exceptions, agree with those published (White et al., 1976).

Table 2 shows the results of the serum electrolytes and serum osmolality values. The sodium, potassium, chloride, calcium and phosphorus values agree with published results (White et al., 1976). The calculated anion gaps are also presented. The anion gaps, for the most part, are increased from the value calculated from one report (White et al., 1976) except for the two captive animals.

Table 3 shows the results of commonly measured serum enzymes. The two muscle enzymes, AST and creatine phosphokinase (CK), showed very different results.

We could not determine any differences based on age or sex in our small sample of the population.

[5] Gemsaec Autoanalyzer, Electro-Nucleonics, Inc., Fairfield, New Jersey 07006, USA.

[6] Technicon Autoanalyzer SMA 12/60, Technicon Corporation, Tarrytown, New York 10591, USA.

[7] Gemini Autoanalyzer, Electro-Nucleonics, Inc., Fairfield, New Jersey 07006, USA.

[8] Osmette A, Precision Systems, Inc., Sudbury, Massachusetts 01776, USA.

TABLE 2. Some electrolytes in blood from 10 manatees.

Animal #	Na mEq/L	K mEq/L	Cl mEq/L	Ca mg/dl	PO_4 mg/dl	Total CO_2 mEq/L	Anion Gap mEq/L	Osmol mOsm/kg H_2O
1	148	5.8	87	9.3	6.4	15	52	310
2	149	5.4	89	10.0	5.2	21	44	312
3	146	5.8	86	8.9	4.8	28	38	305
4[a]	152	5.5	85	10.2	5.6	31	40	303
5	152	5.4	87	10.3	4.9	22	48	308
6[a]	152	6.0	93	9.9	6.5	29	36	310
7[a]	159	4.6	86	9.8	5.9	25	53	314
8[a]	158	5.0	93	10.6	6.9	17	53	324
9[b]	147	4.3	87	9.7	4.0	35	29	307
10[a,b]	151	4.1	96	9.9	4.9	30	29	315
Mean	151	5.2	89	9.9	5.5	25.3	42.2	311
Range	146-159	4.1-6.0	85-96	8.9-10.6	4.0-6.9	15-35	29-53	303-324
Std Dev	4.3	0.7	3.8	0.5	0.9	6.4	9.3	6

[a]Sexually immature animals <275 cm (G.B. Rathbun, pers. comm.)
[b]Captive animals — Sea World of Florida, Orlando

TABLE 3. Values for some enzymes in blood from 10 manatees.

Animal #	ASP[c] IU/l	ALT[d] IU/l	ALP[e] IU/l	CK[f] IU/l
1	10	60	160	492
2	9	45	123	137
3	6	40	140	277
4[a]	7	50	165	87
5	10	60	180	398
6[a]	8	60	125	157
7[a]	13	55	140	895
8[a]	11	65	170	198
9[b]	5	29	115	137
10[a,b]	5	27	105	60
Mean	7	49	142	284
Std Dev	3	14	26	255

[a]Sexually immature animals <275 cm (G.B. Rathbun, pers. comm.)
[b]Captive animals — Sea World of Florida, Orlando
[c]ASP — Aspartate Transaminase, International Units/l
[d]ALT — Alanine Transaminase, International Units/l
[e]ALP — Alkaline Phosphatase, International Units/l
[f]CK — Creatine Kinase, International Units/l

DISCUSSION

At the time of sampling, manatees 1-8 were using Blue Spring Run as a winter warm-water refuge. These animals moved between the fresh, warm spring water and the colder St. Johns River (also fresh) on periodic feeding trips during the winter. Throughout other seasons, the manatees primarily utilized fresh water areas; Blue Spring manatees moving downstream returned upstream when they encountered brackish waters nearer the ocean. How this pattern affected our results cannot be determined until similar studies are done on animals who utilize brackish or salt water areas for prolonged periods. The Blue Spring manatees' behavior may account for the remarkably narrow range of the serum osmolality. If it is true that these individuals represent mainly a fresh water population, one might not expect to see the wider range of serum osmolality values present in groups which move between brackish and fresh water. For example, some values of blood constituents varied considerably when Amazonian fresh water stingrays *(Potamotrygon hystrix)* were adapted to salt water (Bittner and Lang, 1980).

We cannot explain the wide range for blood glucose. Animal #9 was captive, did not struggle and yet had the lowest value. This value would be a low normal for the domestic ruminant herbivore (Medway et al., 1969). Being a nonruminant herbivore, one would have expected a value somewhat higher. In the first 8 animals, where there was much struggling, more in some than in others, one would have expected wide excursions of values due just to catecholamine release. Animal #1 did the most struggling for the longest time. Animal #8 also struggled vigorously.

The nitrogenous waste product values agreed with those published (White et al., 1976). What effect struggling and perhaps some dehydration had on animal #8 is not known, as it did have the highest creatinine value. This result in a terrestrial species would indicate a degree of kidney damage or a diminished blood flow to the kidney as could occur in slight dehydration. Incidentally, this animal also had the highest serum protein level, another indicator perhaps of slight dehydration.

The total iron and total iron binding capacity agreed reasonably well with results from domestic mammals. The low value for animal #6 is not explainable.

The values for total protein and the albumin/globulin (A/G) ratios were somewhat higher than those published with the exception of #'s 9 and 10, both of which had the lowest results for the group. This lower A/G ratio may indicate a change due to a rather sedentary life in captivity or to inadequate nutrition. The albumin/globulin ratio was more closely in agreement with values for humans. In domestic mammals the ratio is usually around unity to somewhat below.

The anion gap (Feldman and Rosenberg, 1981; Gabow et al., 1980) (the unmeasured anions) was calculated by using the formula $[Na^{+} + K^{+} - (Cl^{-} + HCO_3^{-})]$. This is only an approximation since total CO_2 was used as equivalent to HCO_3^{-}. The range found in this study was 29-53 mEq/l. The anion gap calculated from the one published report (White et al., 1976) was 26 mEq/l. The expected range would probably be 25-30 mEq/l for the manatee. This is compatible with the results obtained from the two quiet captive animals, #'s 9 and 10, where they both had an anion gap of 29 mEq/l.

The major cause of increased anion gaps is organic acidosis, likely due to lactic acid. This appears to be the case in our study since there was a certain amount of struggling against capture and restraint. Animals # 1 and 8 struggled the most and had values of 52 and 53 mEq/l. Other causes of increased anion gaps can be sulfate ion, intracellular acids, proteins, phosphorus, etc. (Gabow et al., 1980).

The excursions from the mean of the values for total CO_2 is related to the degree of struggling in the wild-caught animals # 1-8. The captive animals, #'s 9 and 10, were in the range that was expected.

The AST concentrations were not remarkable, and yet the CK concentrations might indicate a wide range of muscle damage due to struggling or to bleeding technique (Bruss and Becker, 1981). These are very difficult to interpret since no published results are available, at least none expressed in international units which can be easily compared.

The ALT and alkaline phosphatase (ALP) results were not remarkable.

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