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HAEMATOLOGY AND PLASMA CHEMISTRY OF CAPTIVE BAIKAL SEALS *PUSA SIBRICA*

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Abstract

The blood values of two Baikal seals are recorded and comparison made with other marine species. The development of the seals and their annual changes were recorded and intrepreted to provide base line data for this little known species.

Introduction

The problems associated with the maintenance of marine mammals in captivity, particulary pinnipeds, have long been recognized and are well documented (RONALD et al., 1969; ENGELHARDT and GERACI, 1978; GERACI, 1972; RIDGWAY et al., 1975). Haematological and plasma chemistry determinations are usually a routine method of assessing the general health of captive animals. Consequently, the need for a sound knowledge of normal blood values for each pinniped species is evident. Such information will provide conformity in experimental animals so that experiments on pinnipeds can be adequately compared. In addition to the above and the medical care of the animal, an animal's blood picture can be a valuable source of information with respect to its environmental demands, way of life and zoological relationships (HAWKEY, 1975).

The blood values of some pinnipeds have been reported (BRYDEN and LIM, 1968; ENGELHARDT, 1979; GERACI, 1971; GERACI and SMITH, 1975; GERACI et al., 1979; GREENWOOD et al., 1971; HAWKEY, 1975; HUNTER and MADIN, 1976; LANE et al., 1972; LENFANT, 1969; PUGH, 1959; RONALD et al., 1969; SIMPSON et al., 1970; TYLER, 1959; others), but few for the Baikal seal (*Pusa sibirica*) (HONG et al., 1982). The Baikal seal is of particular interest in that it represents a near fossil form of pinniped living in the deepest lake in the world, Lake Baikal, located in eastern Russia. It is thus a fresh water seal. There has been much speculation as to its origin, and it is thought to be related to the ringed seal (*Phoca hispida*) of the Arctic, possibly by marine connections in the miocene (KING, 1964).

Clinically useful haematology and plasma chemistry values have been measured over a period of 4 to 6 years, for 2 captive Baikal seals. These should aid researchers in maintaining the health of captive Baikal seals, a fresh water pinniped, as well as presenting information in a previously unknown biological form.

Two animals were studied, thus the results must be regarded as offering unique but limited information. The data have some significance as they were collected over a long period and can therefore be correlated, to some extent, with the growth and development of the seal. This includes such considerations as disease, moult and stress responses, which have previously been shown to influence blood levels in other species (GERACI, 1972; GERACI et al., 1979).

Materials and Methods

In April 1976 a male and female Baikal seal were captured in Lake Baikal. They were young of the year (SLENO, MANSFIELD and SMITH - personal communication). After a two week observation and quarantine period in Moscow, followed by two days in Harderwijk, Holland, for further observation, they were then brought to Guelph on May 25th. They were initially held in an isolated indoor "nursery tank". After a period of a month, they were moved to a larger indoor holding tank equipped with a haul out ledge and a continuous flow of fresh water ($10° \pm 3°C$). The seals were on a diet of supplemented herring (*Clupea harengus*) (Table 1).

TABLE 1

Supplements

Calcium	11.4 mg/day
Iron	18.8 mg/day
NaC1	1.2 g/day
Vitamin B_1	270.9 mg/day
Vitamin B_2	30.9 mg/day
Niacinamide	1057 mg/day
Pyridoxine	10.9 mg/day
Vitamin B_{12}	20.6 ug/day
Folic Acid	0.6 mg/day
Vitamin A	4.7 mg/day
Vitamin C	628.6 mg/day
Vitamin D	0.013 mg/day
Vitamin E	147 mg/day

Blood sampling was carried out monthly. The male died in May of 1980. Monthly sampling is still carried out on the female. The 1976-82 values are considered in this report. The animals were physically restrained during blood sampling. For the first year or so, if the animals were particularly restless they were restrained using a "bleeding bed"; a padded V-shaped trough with canvas straps crossing over the body (RONALD et al., 1969). Later they reacted less to being handled and were restrained by nets, with one person straddling the seal and one person taking the blood sample. The seals were fasted 12-18 h prior to sampling.

A vacutainer needle assembly (Becton, Dickinson Co., Rutherford, N.J.) was used to draw blood from vessels in the plantar aspect of the hind flipper (GERACI, 1971). Blood was collected into K-EDTA tubes for immediate routine haematology, heparinized vacutainer tubes and evacuated serum separation tube (Becton Dickinson Canada, Mississauga, Ontario) for plasma chemistry and electrolyte analysis. Packed cell volume (haematocrit) was determined using the capillary tube microhaematocrit method. A Coulter counter and haemaglobinometer were used for the total erythrocyte and leucocyte count (red and white blood cell) and haemoglobin (Hb) determination respectively (Coulter Electronics Inc., Hialeah, Florida). The mean cell volume (MCV), mean cell haemoglobin (MCH) and mean cell haemoglobin concentration (MCHC) were calculated. Microelectrodes on a micro-astrup system (Radiometer, Denmark) were used in connection with a digital acid-base analyzer to measure partial pressures of O_2, CO_2 and pH. Sodium and potassium ion concentrations were determined by flame photometry using a lithium internal standard. All of the above determinations were done in duplicate.

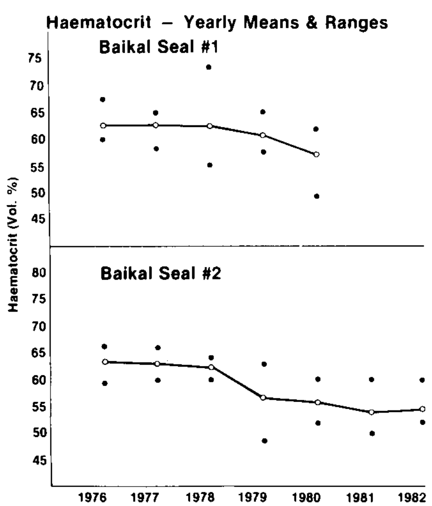
In the 4 to 6 year period in which the data were collected, some changes in technique occurred in the plasma chemistry measurements as techniques were updated to increase their accuracy. From June 1976 to August 1979, calcium was determined by atomic absorption spectrophotometry (TRUDEAU and FREIER, 1967); creatinine by the Jaffe reaction (OWEN et al., 1954); phosphorus via reduction of phosphomolybdate (GOLDENBERG and FERNANDEZ, 1966); blood urea nitrogen (BUN) using diacetyl monoxime thiosemicarbazide (COULOMBE and FAVREAU, 1963; CROCKER, 1967); glucose with a method based on the condensation of the aldehyde glucose, with the primary aromatic amine O-toluidine (FETERIS, 1965); cholesterol by the WYBENGA et al., 1970, method; bilirubins were determined using the Jendrassik method as modified by Nosslin (MICHAELSSON, 1961); alkaline phosphatase by the "phosphastrate alkaline" method (BABSON et al., 1966); lactate dehydrogenase (LDH), serum glutamate-oxalacetate transaminase (S-GOT) and serum glutamate-pyruvate transaminase (S-GPT) were all analyzed by the ultra violet kinetic method, using a LKB reaction rate analyzer (GAY et al., 1968; KARMEN et al., 1955; WROBLEWSKI and LaDUE, 1956). From August, 1979 to the end of the study, all of the clinical chemistry levels were measured using a KDA[2] analyzer (American Monitor Corporation, Indiana). Magnesium, chloride and osmolality measurements were unchanged throughout the experiment: magnesium was measured by atomic absorption spectrophotometry (HANSEN and FREIER, 1967); chloride by coloumetric titration and a Buchler-Cotlove Chloridometer (Buchler Instruments Inc.) (COTLOVE et al., 1958); osmolatity using an advanced osmometer model 3D (Advanced Instruments Inc., Massachusetts).

All pinnipeds moult, this critical phenomenon was recorded, commencing with the presence of loose hair both on the seal and in the tanks and by the growth of a new silver coloured pelage.

Statistical comparisons of each blood constituent were made between the two seals using a t-test for unequal variances.

Results

Haematology: HAWKEY's (1975) and the present values for the Baikal seal, along with data from some previous pinniped and human blood studies are listed for comparative purposes and as a broad reference (Table 2). More meaningful, chronological presentations are displayed in Figs. 1-4.



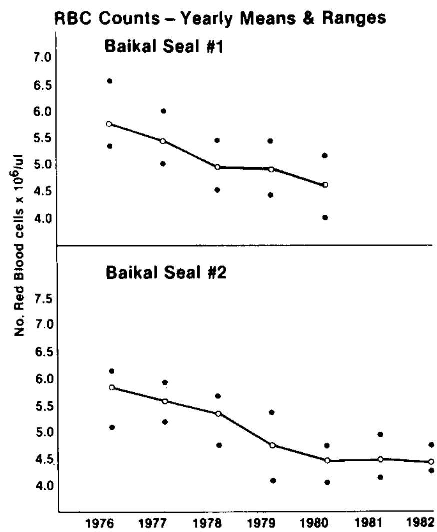


TABLE 2: Comparison of Physical Blood

SPECIES	AGE	pH	pO_2 mmHg	PCO_2 mmHg	HAEM GLOBI g/100 m
Baikal Seal 1 *(Pusa sibirica)*		7.28 (7.19-7.38)	63.9 (46.8-90.6)	47.7 (36.1-64.3)	24.3 (19.5-27
Baikal Seal 2		7.34 (7.18-7.43)	75.0 (53.0-125,2)	42.4 (25.7-56.2)	23.3 (20.0-26
Baikal seal [1]					18
Ringed seal [2,3,11] *(Phoca hispida)*	2 years wild netted	7.37 (7.29-7.50)	75.9 (37.1-209.5)	45.8 (32.3-59.0)	26 (24-27
					26.5 (23.0-29
Harp seal [4,2,5] *(Phoca groenlandica)*		7.29 (7.13-7.46)	58.4 (33.0-89.4)	21.0 (10.8-37.3)	22.1 (18.2-26
					26 (25-28
					25.2 (21.8-25
Harbour seal [2] *(Phoca vitulina)*	1-2 years				20 (19-23
Grey Seal [6,11] *(Halicoerus grypus)*		7.28 (7.17-7.36)	97.8 (50.0-183.3)	48.4 (35.6-54.7)	19.1 (14.4-21
Southern elephant seal [7] *(Mirounga leonina)*					24.0
Northern elephant seal [8] *(Mirounga angustirostris)*					25
Weddell seal [9] *(Leptonychotes weddelli)*					23.8
Crabeater seal [10] *(Lobodon carcinophagus)*					18.2
Man [1]		7.27-7.39	83-100		14.4 (12.3-17.3)

References:

1 Hawkey (1975)
2 Engelhardt (1979)
3 Geraci and Smith (1975)
4 Ronald *et al* (1969)
5 Geraci (1971)
6 Greenwood *et al* (197
7 Lane *et al* (1972)
8 Ridgway (1972, as cite
9 Pugh (1959)
10 Tyler (1959)

hysical Blood Properties of Some Pinnipeds and Man

HAEMO-GLOBIN g/100 ml	HAEMAT-OCRIT Vol. %	ERYTHRO-CYTES no.x 10^6/ul	M.C.V. u^3	M.C.H. pg	M.C.H.C. %	LEUCOCYTES ul^{-1}
24.3 (19.5-27.0)	61.2 (49.0-73.2)	5.04 (4.00-6.57)	121.9 (92.7-141.3)	48.1 (36.4-54.1)	39.7 (34.6-43.3)	9542 (5000-14390)
23.3 (20.0-26.0)	57.5 (48.5-66)	4.83 (4.02-6.10)	119.3 (91.1-139.4)	48.5 (35.3-62.1)	40.7 (35.3-48.2)	9235 (5403-16681)
18	66.5	5.5 (5.3-5.6)	122 (121-123)	47.5 (46-49)	38.0 (36-40)	5600 (3400-7800)
26 (24-27)	63 (61-66)	5.5 (5.0-5.9)	115 (110-122)	47 (46-48)	41 (39-43)	
26.5 (23.0-29.1)	68.5 (61.0-75.0)	5.39 (4.53-6.31)	135 (116-150)	49.4 (42.9-57.4)	38.2 (36.3-41.4	11472 (6132-24774)
22.1 (18.2-26.4)	46.6 (38.5-53.0)	5.11 (4.04-6.11)	92.4 (73.3-115.9)	44.2 (29.5-59.7)	47.4 (40.3-56.8)	9910 (5600-24100)
26 (25-28)	62 (55-65)	5.1 (4.6-6.3)	121 (107-130)	51 (44-56)	42 (40-43)	
25.2 (21.8-25.2)	59.2 (53.5-65.2)	4.57 (4.09-5.07)	130.5 (119-142)	55.4 (49.6-61.3)	42.3 (40.6-43.8)	7800 (5300-10100)
20 (19-23)	55 (51-62)	5.1 (4.6-5.7)	111 (102-115)	41 (36-43)	37 (35-40)	10200 (7800-13100)
19.1 (14.4-21.9)	57.2 (46.0-66.5)	5.04 (4.36-5.90)	113 (92-124)	38.0 (31-42)	33.4 (28-37)	10663 (6550-16600)
24.0	60.6	2.54	239.1	95.5	39.6	
25	63.5	5.55	114	45	39.3	9600
23.8	62.8	3.74	168.0	63.5	37.9	
18.2		4.41		41.3		
14.4 (12.3-17.3)	43.9 (37-51)	4.8 (4.1-6.1)	91.0 (70-90)	30.0 (26-35)	32.8 (27-37)	6600 (4100-12000)

971)
od *et al* (1971)
al (1972)
(1972, as cited by Hawkey, 1975)
59)
59)

11 K. Ronald, unpublished data
12 Hunter and Madin (1976)
13 Geraci *et al* (1979)
14 Damm, H.C. (1965)
15 Ronald and Thompson (1981)
16 Altman and Dittmer (1961)

Both seals exhibited a lowering of their erythrocyte counts with captive longevity. Decreases occurred simultaneously or immediately prior to the moult, with the exception of the 1977 moult of Seal 2 where an increase followed a decrease. In addition to the changes during moult, the erythrocyte counts also fluctuated throughout the study (Fig. 2).

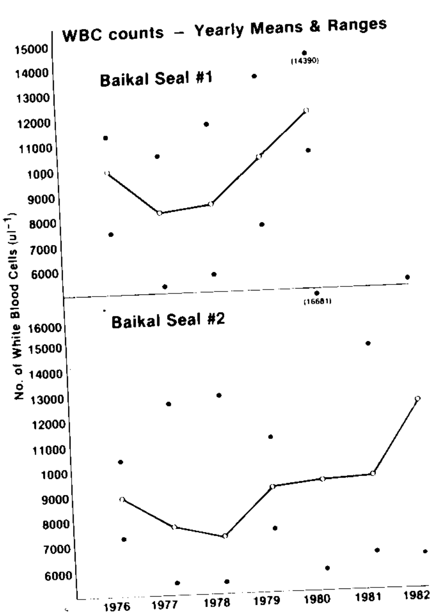
Monthly fluctuations occurred in haemoglobin and haematocrit levels (Figs. 4 and 1). In 1977 and 1980 Seal 1's haemoglobin values decreased during moult. In 1978 and 1979 values decreased before moult and increased during moult. A similar situation was seen for Seal 2 in that both decreases (1977, 1978, 1980, 1981, 1982) and an increase preceded by a decrease (1978) during moult.

Monthly variations in haematocrit levels followed similar patterns, decreasing during or immediately prior to moult, in which case increases followed. In one instance, Seal 2's haematocrit remained constant at moult, however decreased prior to and increased after moult.

In June 1978 Seal I showed a simultaneous fluctuation in haemoglobin, decreasing from 27 g/100 ml of blood to 21.3 g/100 ml, and a haematocrit drop of 55 volume percent from a high of 73.2. In June 1979 the seal exhibited a decrease followed by an increase in both haemoglobin and haematocrit. The seal before its death in May 1980, exhibited a marked depression in its blood values.

For Seal 2, the haemoglobin and haematocrit decreases for May to June 1979 and January to March 1981, were followed by increases. In November 1980, Seal 2's haemoglobin increased to 4.8 g/100 ml of blood and eventually reached a maximum of 26 g/100 ml two months later.

Total leucocyte counts, as a reflection of the general health of the animals varied substantially for both seals throughout the study (Fig. 3). Seal l's values varied between a low of 5000 cells/µl recorded in August 1972, and a high of 14,390/µl in February 1980, three months prior to its death. A particularly abrupt drop was seen during June 1978, at which time the seal's white



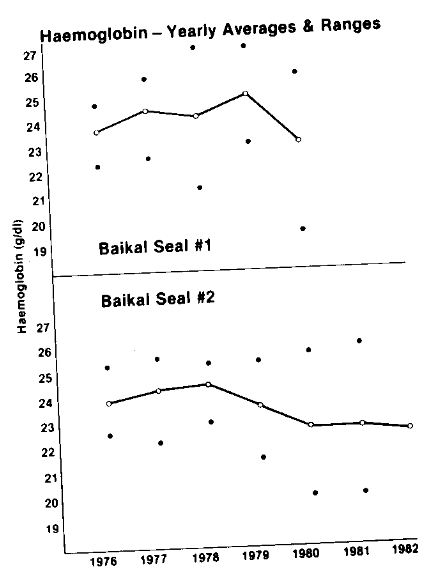


Table 3: Comparison of Blood Chemistry Levels for Some Pinnipeds and Man

SPECIES	BLOOD UREA NITROGEN mg/dl	CHOL-ESTEROL mg/dl	TOTAL PROTEIN g/dl	GLUCOSE mg/dl	CREAT-ININE mg/dl	URIC ACID mg/dl	OSMO-LALITY m/Osl	S-GOT IU	S-GPT IU	LDH IU	ALKA-LINE PHOSPHAT-ASE IU	BILIRUBIN, TOTAL mg/dl	FREE mg/dl	CON-JUGATED mg/dl
BAIKAL SEAL 1	48.1 (26-79)	336 (257-445)	7.0 (3.5-5.5)	171 (122-226)	1.4 (.5-1.7)	2.1 (.9-2.7)	344 (318-362)	86 (30-206)	44 (3-133)	324 (187-829)	55 (14-246)	.80 (.1-1.6)	.28 (0-.7)	.55 (0-1.5)
BAIKAL SEAL 2	33.9 (15-59)	277 (180-378)	7.0 (5.8-8.1)	188 (95-289)	1.4 (.8-2.3)	2.0 (.9-3.3)	329 (309-348)	95 (6-376)	50 (9-480)	274 (155-729)	103 (12-254)	.57 (.1-1.3)	.23 (0-.5)	.45 (O-.5)
Ringed seal[3] - Free *(Phoca hispida)*	42	320		151		2.3						.4 (.1-.7)		
Captive [2,3,11]	39 (29-57)	276 (220.328)	7.3 (6.3-8.8)	150 (115-173)	1.2 (.9-1.4)	1.2 (.5-2.6)	320 (302-339)	46 (17-79)	44 (33-62)	241 (181-316)	82 (34-105	.25 (0.1-0.4)	.19 (0—.3)	.071 (0-0.2)
		(....................average	from	1	year....................)		(..average from	1 year...)		(..............................	..........average	from	1 year	..............................)
Harp seal [11] *(Phoca groenlandica)*	40.3 (29-57)	307 217-576)	7.1 (5.8-8.8)	146 (119-173)	1.5 (1.1-2.0)	1.7 (1.5-2.3)	326 (308-345)	75 (13-318)	57 (4.6-226)	166 (113-245)	34.6 (7.8-61.7)	.42 (.1-.73)	.17 (.1-.4)	.25 (.1-.4)
Harbour Seal [15] *(Phoca vitulina)*	42.3	281.3	7.75	138.8	1.30	1.3	333.8	20.6	9.8	.203	15.4	0.6	0.20	0.3
Grey seal [6, 11] *(Halichoerus grypus)*	74 (32-108)	242 177-330)	9.5 (8.0-11.6)	104 (90-112)	1.62 (1.20-3.30)	1.1 (.7-1.5)	327.8 (315.0-351.0)	43 (24-59)	16 (11-30)	188 (95-325)	96.6 (54-264)	.15 (0-.23)	.11 (0-.20)	.05 (0-.20)
S. elephant seal *(Mirounga leonina)*		445.8	5.9											
Northern fur seal [12] *(Callorhinus ursinus)*	40.8 (29.5-49.9)	319 (188-509)	7.1 (6.4-8.2)	96 (12-187)	1.4 (1.0-1.7)	3.1 (1.8-5.5)		106 (83-144)	21 (17-30)	708 (641-1028)	48 (31—89)	1.8 (.3-9)		
Man [1, 12] *(Homo sapiens)*	(7-20)	(150-250)	(6-8)	(60-110)	(.5-1.5)	2.7		(5-20)	4-25)	(30-110)	(9-35)	(.2-1.2)		

See TABLE 2 for list of references

counts went from 11,700/µl to 5716/µl. Seal 2 had a similar range, with a low of 5403/µl in February 1978, and a high of 16,681/µl in March 1980.

Plasma Chemistry: The plasma chemistry and electrolyte values obtained for the Baikal seals, other pinnipeds and man are shown (Table 3 and 4).

The chemical levels that did not statistically vary between the two individuals studied were magnesium, blood urea nitrogen, cholesterol, glocose, osmolality, alkaline phosphatase, total, free and conjugated bilirubins.

Discussion

As the results reported here are for 1 or 2 animals, they do not represent statistically valid normal ranges and should be used with caution. Intraspecific variations existed but it was possible to recognize each seal's blood values and the modifications associated with both environment and health.
HAWKEY (1975) noted that haematological findings may vary due to the long-term effects of a captive environment on the animal's health. The moulting season of the captive seals occurred between February and May whereas in nature it is May and June (KING, 1964). This could be attributed to the different photoperiod experienced by captive seals.
Age and circannial development significantly influence levels of certain plasma constituents in pinnipeds (BRYDEN and LIM, 1969; GERACI, 1971; GERACI et al., 1979; RONALD, 1970; RONALD et al., 1969).
The patterns found in the Baikal seal during erythrocytic fluctuations of moult corresponded in part to those for harp seals (*Phoca groenlandica*) (RONALD et al., 1969). They stated that the moulting period is one of great stress and decreases in erythrocyte counts, hameoglobin and haematocrit occur. Decreases did not always occur in the Baikals during moult and in some cases decreases prior to, and actual increases occurred at moult.
One possible explanation for the gradual decrease in erythrocyte numbers as the study progressed may be related to stress. Stress, caused by unfamiliar surroundings can cause the spleen to contract, due to a series of neurohormonal events, resulting in elevated red cell levels, up to 25% over resting values (SCHALM, 1965 as cited by GERACI and SMITH, 1975). As the animals acclimated and the bleeding procedure became less traumatic, they were less likely to turn to this stress demanded increase in oxygen carrying capacity.
Following the general pattern established for phocids (LENFANT et al., 1970), the Baikal seal also showed relatively higher haemoglobin and haematocrit levels than man. Haemoglobin ranged from 35-88% higher than the average human values, and haematocrits 10-67% higher. Previous studies have shown that among diving mammals there is a definite trend for species which normally endure long dives to have the higher haematocrit and haemoglobin values (LENFANT et al., 1970). Although the Baikal seal is said to dive to the bottom of the lake and therefore can be called a deep diver it will be necessary, before comparing the diving capablities of Baikals with other phocids, to further investigate the blood volume and myoglobin concentrations of the species.
The haemoglobin level and haematocrit were fairly variable and decreased prior to and during the moult. The large fluctuations observed in Seal 1's values in June, 1978, coincided with rectal bleeding. Also, the blood levels of both haemoglobin and haematocrit decreased prior to the animal's death. Haemoglobin concentrations as well as erythrocyte counts may also vary due to the concentration of the spleen caused by stress (TURNER and HODGETTS, 1959 as cited by LANE et al., 1972). The haemoglobin and haematocrit which decreased in January to March 1981 for Seal 2 occurred concurrently with the appearance of sores on the seal's back, and a poor appetite. There was no apparent clinical reason for the seal's large increase in haemoglobin in November 1980 and in January 1981. Evidently the emotional and physical

TABLE 4: Comparison of Electrolyte Values for Some Pinnipeds and Man

SPECIES	SODIUM meq/1	POTASSIUM meq/1	CHLORIDE meq/1	CALCIUM mg/100 ml	PHOSPHOROUS mg/100 ml	MAGNESIUM mg/100 ml
BAIKAL SEAL 1	156 (150-163)	3.8 (2.9-4.6)	109 (96-119)	9.6 (7.8-13.0)	5.1 (3.1-9.2)	2.1 (1.6-2.4)
BAIKAL SEAL 2	155 (148-162)	3.8 (3.2-4.4)	110 (103-117)	9.6 (8.4-10.9)	4.9 (3.0-9.0)	2.4 (1.7-7.4)
Ringed seal [13,2,11] *(Phoca hispida)*	154 (149-166)	4.3 (3.4-5.4)	102 (84-112)	9.1 (8.8-10.2) (..........average	5.1 (3.3-7.1) from one	2.0 (1.5-2.4) year..........)
	157 (154-159)	4.4 (4.1-4.8)				
Harp seal [11] *(Phoco groenlandica)*	154 (148-162)	3.8 (3.2-5.4)	105 (101-111)	9.1 (8.7-9.7)	5.1 (4.4-5.8)	1.9 (1.5-2.3)
Harbour seal [2,15] *(Phoca vitulina)*	166 (160-168)	5.0 (3.5-6.0)	107.5	9.0	4.5	2.0
Grey Seal [6,11] *(Halichoerus grypus)*	159 (153-168)	4.5 (4.2-4.8)	108 (106-114)	11.2 (9.9-124)	5.6 (3.8-7.3)	3.3 (3.0-3.9)
Southern elephant seal *(Mirounga leonina)*	146.8	3.8				
Northern fur seal [12] *(Callorhinus ursinus)*				11.5	5.6	
Weddell seal [9] *(Leptonychotes weddelli)*	145	8.2		4.5		2
Man [9,12,16] *(Homo sapiens)*	(138-147)	(3.9-5.0)	102.4 (98-108)	(9-12)	(2.5-5.0)	2.1 (1.6-2.6)

See TABLE 2 for list of references

state of the animal at the time of bleeding can alter the haemoglobin concentration (LANE et al., 1972). This is further substantiated in haemoglobin concentrations in northern elephant seals (*Mirounga angustirostris*), (LENFANT (1969) and in harp seals (RONALD, 1970), which were lower than wild subjects. This could possibly explain the low haemoglobin values found by HAWKEY (1975) from Baikal seals.

The MCV, MCH and MCHC values all fell within the ranges of HAWKEY's (1975) values for Baikal seals. The MCV and MCH differed however, from values found for many other Pinnipedia, closely approximating those of ringed seals (ENGELHARDT, 1979; GERACI and SMITH, 1975). LENFANT (1969) stated that in spite of differences in MCV and MCH, the MCHC does not vary greatly between pinnipeds species.

The mean white cell counts were similar in both species, the range however, was large making it difficult to determine a "normal" value. Although large fluctuations in white counts occurred when Seal 1 was bleeding from the rectum (June, 1978) and when Seal 2 had sores and a poor appetite (January to March, 1981), but there were many occasions when fluctuations could not be correlated with the obvious physical state of the animal. A number of the enzyme levels, exhibited by the Baikals, including S-GOT, S-GPT, Alkaline phosphatase and LDH, were appreciably higher than normal human values. HUNTER and MADIN (1976) also found elevated levels of LDH, S-GOT and alkaline phosphatase in the northern fur seal (*Callorhinus ursinus*), but did not find elevated S-GPT levels. Similarly, GREENWOOD et al., (1971) did not report elevated levels of S-GPT for young grey seals (*Halichoerus grypus*) even though their S-GOT values were high compared to humans as were S-GOT values for captive ringed seal's (RONALD unpublished data). Conversley elevated levels of S-GPT are known (ENGELHARDT, 1979; RONALD and THOMPSON, 1981; RONALD, unpublished data) for other pinnipeds, the differences in S-GPT levels could be due to different analytical methods (ENGELHARDT, 1979). HUNTER and MADIN (1976) state that the probable reason for this enzyme elevation in the northern fur seal was unavoidable haemolysis of the blood samples or stress associated with herding seals prior to their death.

BUN, cholesterol and glucose, were higher than for humans. Glucose was also substantially higher for the Baikal than the values reported for other pinnipeds (GERACI et al., 1979; GREENWOOD et al., 1971; HUNTER and MADIN, 1976; RONALD, unpublished data), being closest to GERACI et al's (1979) values for free ranging ringed seals. Cholesterol and BUN levels were comparable to those determined for captive healthy ringed seals (GERACI et al., 1979) and northern fur seals (HUNTER and MADIN, 1976). The reasons why elevated BUN and glucose values have been found in marine mammals (MEDWAY and GERACI, 1966; GREENWOOD et al., 1971, HUNTER and MADIN, 1976; RIDGWAY, 1965) are not understood. GREENWOOD et al., (1971) suggests that it may be related to their high protein and fat diet, and that it is a reflection of their dependence on gluconeogenesis for energy metabolism. RIDGWAY (1965) proposed that elevated BUN levels may be related to osmoregulation. The blood glucose levels varied greatly (from 95 mg/dl to 289 mg/dl) which parallel MEDWAY and GERACI's (1966) observations on the bottlenose dolphin (*Tursiops truncatus*), who suggested that variation was probably a result of struggling just prior to sampling.

According to GERACI et al., (1979) uric acid can also be influenced by stress, resulting in elevated levels. The reasons for this remain unclear, and contradictions have been found. The plasma uric acid determinations from this study were within the ranges for other pinnipeds (GERACI *et al.*, 1979; HUNTER and MADIN, 1976; RONALD, unpublished data).
Plasma, sodium and potassium concentrations were comparable to values found for harp seals

(RONALD, unpublished data), and ringed seal (ENGELHARDT 1979, GERACI *et al*, 1979), but lower than GREENWOOD et al's (1971) values for young grey seals and ENGELHARDT's (1979) values for harbour seals. Plasma sodium is of particular importance in that, hyponatremia (low blood sodium) is found in captive phocids and otariids and is often associated with stress (GERACI et al., 1979). Sodium levels of the Baikals never reached the low levels of 140-144 meq/l exhibited by moulting, thin, lethargic ringed seals but were closer to the 154 meq/l for healthy captive ringed seals (GERACI et al., 1979).

The blood parameters of the Baikal seal with the exception of glucose were found comparable in range to those for other pinnipeds corroborating HAWKEY's work (1975). The monthly fluctuations in haematology were also modified by the holding condition of the seal but still these values are of value in recognizing abnormal haematological values for Baikal seals.

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