

## A Hematological Study of the Walrus, *Odobenus rosmarus*

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Wolk E. & Kosygin G.M., 1979: A hematological study of the walrus, *Odobenus rosmarus*. Acta theriol., 24, 9: 99—107 [With 2 Tables & Figs.]

In 62 walruses caught in the northwestern Chukchi Sea hemoglobin value (Hb), number of erythrocytes (RBC), diameter of erythrocytes (RBC diam.), mean corpuscular hemoglobin (MCH), number of leukocytes (WBC) and sedimentation rate of blood cells (SR) were studied. In adult walruses these parameters are as follows: Hb —  $17.0 \pm 2.2$  g/100 ml; RBC —  $2.89 \pm 0.9 \times 10^6$ /cmm; RBC diam. —  $7.78 \pm 0.6$   $\mu$ m; MCH —  $59.66 \pm 16.8$  pg; WBC —  $6.244 \pm 266$ /cmm; SR —  $4.8 \pm 2.2$  mm/h. In the walrus hemoglobin concentration is higher than in pelagic *Otaridae*, yet it is lower than in *Phocidae* which are excellent divers. The RBC count is lowest among the pinnipeds and is among the lowest value known for any mammal. Red blood cells are big and contain much hemoglobin. There is a positive correlation between the body weight of fetuses and pups and their hemoglobin concentration ( $r = .797$ ) and the RBC value ( $r = .958$ ). In adult males a negative correlation between the body weight and hemoglobin concentration was observed ( $r = -.577$ ).

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### 1. INTRODUCTION

Pinnipeds comprise a group of mammals extremely interesting for physiological studies in view of their aquatic life style and ability to dive. Thus they have been subjected to considerable hematological investigation as blood morphology and biochemistry can elucidate aspects of their adaptation to subaqueous activities. Basic blood parameters are known for over half of the species of the Order *Pinnipedia* (for review see Lane *et al.*, 1972 and: Kraft, 1966; Sokolov, 1967, 1969; Ronald *et al.*, 1969; Vallyathan *et al.*, 1969; Lenfant *et al.*, 1970; Kusin, 1972; Glazova, 1972, 1974). These species belong to two Families, *Otaridae* and *Phocidae*. The third Family *Odobenidae*, has been the least studied hematologically, though some data were given by Sokolov (1967) and Lenfant *et al.* (1970).

We therefore report hematologic parameters of walruses (*Odobenus rosmarus* Linnaeus, 1758) taken in the northwestern part of the Chukchi Sea (part of the Arctic Ocean).

## 2. MATERIAL AND METHODS

Blood from 62 walrus (14 adult males, 6 sexually immature males older than one year — «subadults», one male pup, 35 adult females, 3 subadult females, and 3 female pups) was examined. The animals were shot from 20 June to 5 September 1973. Seven fetuses aged 2—3 months were also examined.

Blood was taken during migration of walrus from their wintering sites to the summering areas and during their stay there. Pods consisting of only males were observed as well as of mixed sex and age congregations consisting of hundreds or thousands of individuals. Body weight and body length were

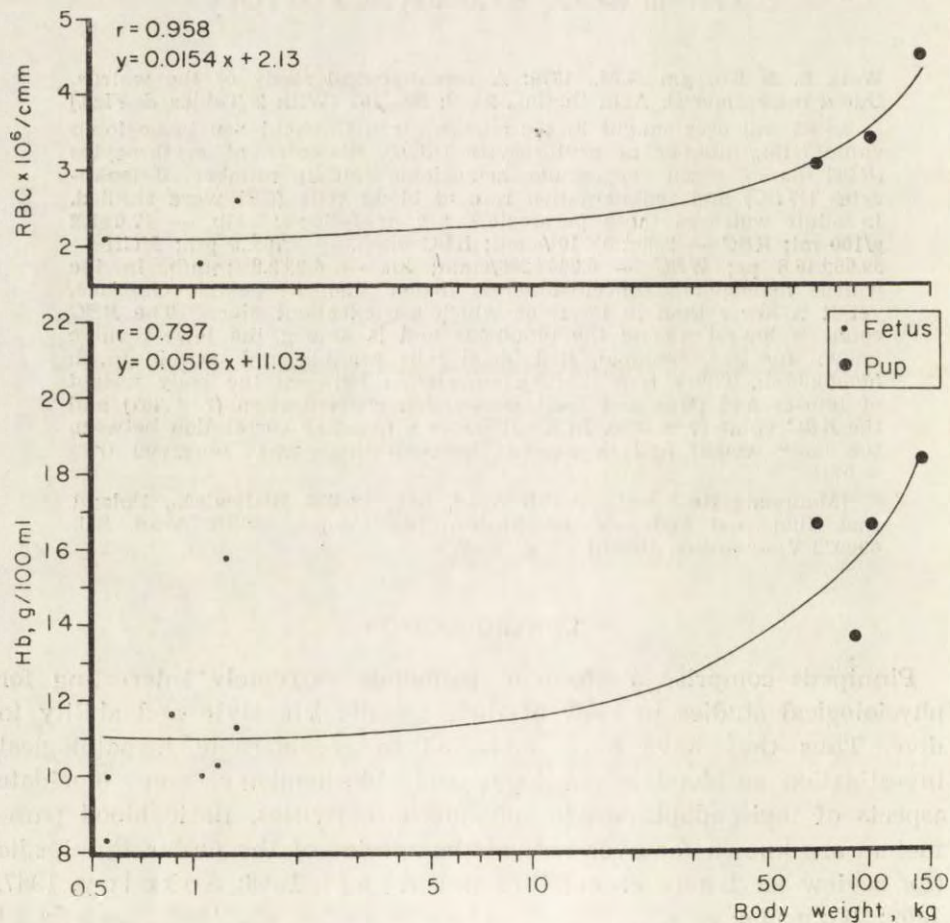


Fig. 1. Correlation between body weight, Hb values and RBC parameters in young walrus.

determined for all walrus. Body length was measured along the back from tip of the nose to end of the tail. Blood was drawn from cranial vessels immediately after death (fetuses were removed from the uterus) using sodium citrate as an anticoagulum. Blood tests were performed immediately. Hemoglobin concentration (Hb) was determined with a Sahli hemometer. Erythrocytes (RBC) and leukocytes

(WBC) were counted in a Bürker's chamber. Erythrocyte diameter (*RBC diam.*) was measured with a Zeiss ocular micrometer on smears stained by Pappenheim's method. Blood sedimentation rate (*SR*) was defined by the micromethod. Mean corpuscular hemoglobin concentration (*MCH*) was calculated.

### 3. RESULTS

No statistically significant differences in values of blood parameters among adult males and females were noted. Mean values were therefore

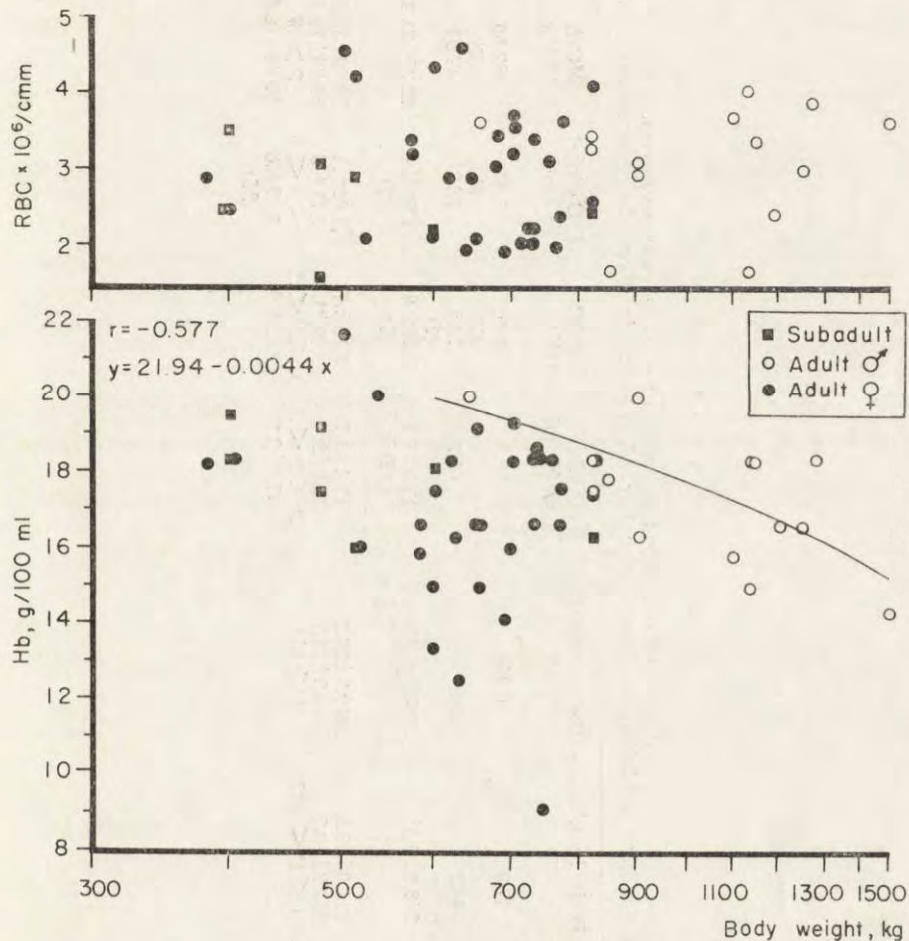


Fig. 2. Correlation between body weight, Hb values and *RBC* parameters in subadult and adult walrus.

calculated from pooled adult data. Due to the small number of individuals in other age groups, the sexes were also treated jointly (Table 1).

Table 1

Parameters of blood in the walrus, *Odobenus rosmarus*. Mean values and standard deviation is shown. Number of samples is given in parentheses. M — males, F — females.

Age, sex	No. of anim.	Body length, cm	Body weight, kg	Hb, g/100 ml	RBC, $10^6/\text{cmm}$	RBC diam., $\mu\text{m}$	MCH, $10^{-12}$ g	WBC/cmm	Sediment rate, mm/h
Fetuses M+F	7	37.8	0.959	11.0	2.16 (3)	7.85 (6)	52.00 (3)	12,125 (4)	7.0 (4)
Pups M+F	4	144.2	100.0	16.7	3.65 (3)	7.10	47.98	6.067	3.0
Subad M+F	8	248.6±9.5	525.0±135.0	17.8±1.3 (7)	2.60±.6 (7)	7.50±.4 (7)	72.37±21.3 (7)	6,150±219 (7)	5.0±1.6 (7)
Adults M	14	311.0±29.2	1049.3±23.1	17.4±1.7	3.13±.7	8.00±.7	59.26±18.3	6,150±185	5.7±2.9
F	35	283.3±22.7	668.2±11.7	16.8±2.4	2.79±1.0	7.71±.5	59.85±16.4	6,339±297	4.4±1.7
M+F	49	.001 < P < .002	P < .001	.2 < P < .5 17.0±2.2	.1 < P < .2 2.89±.9	.2 < P < .5 7.78±.6 (26)	P > .5 59.66±16.8	P > .5 6,244±266	.05 < P < .1 4.8±2.2

During the growth of walruses a rise in those blood parameters affecting respiratory functions was observed. Hemoglobin concentration rises from 11.0 g/100 ml in fetuses to 17.0 in adults ( $P < .001$ ; Table 1). There is also a correlation between the body weight and Hb value in fetuses and pups ( $r = .797$ ;  $.001 < P < .01$ ; Fig. 1). This relation is different in adults. In males there is a negative correlation between the body weight and Hb ( $r = -.577$ ;  $.5 < P < .02$ ). In female adults there is no correlation (Fig. 2).

In four cases there is possible a comparison of Hb value in a pregnant female and its fetus. In three of these cases a definite relation between these parameters was observed i.e. the higher value in a female resulted in a higher value in the fetus (Table 2).

Table 2

A comparison of blood parameters of pregnant females *Odobenus rosmarus* and their fetuses.

M — male, F — female, f — fetus.

	Body length, cm	Body weight kg	Hb, g/100 ml	RBC $10^9$ /cmm	MCH, $10^{-12}$ g	WBC/cmm	Sediment. rate, mm/h
F <sup>1</sup>	270.0	740.00	18.6	3.36	55.36	6,200	6
Ff <sup>1</sup>	36.0	1.25	15.8	2.61	60.34	7,200	—
F <sup>2</sup>	300.0	740.00	18.3	2.24	81.70	9,150	8
Mf <sup>2</sup>	28.0	0.55	10.0	—	—	—	—
Mf <sup>3</sup>	30.0	1.05	10.0	1.80	55.55	12,500	8
Mf <sup>3</sup>	30.5	1.15	10.3	—	—	13,400	12
F <sup>4</sup>	285.0	600.00	15.0	2.08	72.11	14,500	—
Ff <sup>4</sup>	33.0	0.86	11.6	—	—	—	5
F <sup>4</sup>	268.0	640.00	13.3	4.57	29.10	4,900	3
Mf <sup>4</sup>	40.0	1.30	11.3	—	—	—	3
Mf <sup>4</sup>	25.0	0.55	8.3	2.08	39.90	15,400	—

Date caught: <sup>1</sup> Aug. 24, <sup>2</sup> Aug. 26, <sup>3</sup> Sept. 4, <sup>4</sup> Sept. 5.

RBC count of fetuses and pups was correlated with body weight ( $r = .958$ ;  $.001 < P < .01$ ; Fig. 1). Yet in subadult and adult specimens no correlation between RBC and body weight was found (Fig. 2). There also is no mutual relationship between body size of walruses and MCH and SR. Thus increased Hb and RBC value seen closely corresponds to age, since body weight is age-related in walruses (Krylov, 1970). Fetal WBC value is twice that of neonates. This value does not change further during the animal's life (Table 1). The mean blood sedimentation rate of adults was 4.41 mm/h, the maximum rising above 10 mm/h in only one individual (13 mm/h). Therefore it was assumed after Sokolov (1967) that those values accurately reflected the normal physiological condition of adult walruses.

## 4. DISCUSSION

Elevation of blood parameters during the growth of the walrus is probably consequent upon a change in the way of the life of the young animal, i.e. adaptation to swimming and getting food from the sea bottom which in turn, demands increased oxygen availability while diving. According to Nyholm (1975) the average walrus dive duration was 4.8 min. Perry (1976) cited dive depths to 90 m lasting 8—10 min. In many other species of pinnipeds the period spent under water is much longer (Kooyma, 1966). A distinct rise in hemoglobin concentration, RBC number, MCH, MCHC, MCV values and the blood volume is observed during the postnatal development of expertly diving species (Bryden & Lim, 1969; Geraci, 1971; Lane *et al.*, 1972). Most species of pinnipeds have higher Hb concentration than does the walrus. According to our data mean value is 17.0 g/100 ml; Sokolov (1967) states 14.0—17.0 and Lenfant *et al.* (1970) cite 16.7 g/100 ml in adult walruses. Pinnipeds exhibit a higher basic metabolisms (Irving & Hart, 1957) but unfortunately no data exist concerning walrus metabolic rate. It may be supposed that Hb values and metabolic rates are related. Walruses are lethargic, resting ashore or on ice, even migrating by riding ice-floes over long distances. They eat torpid shallow water *Mollusca* and *Crustacea* (Chapskij, 1936; Nikulin, 1941; Krylov, 1971). Walruses do not swim very fast compared with carnivorous pinnipeds. In Weddell seals (*Leptonychotes weddelli*) and harp seals (*Pagophilus groenlandicus*) which cover large distances very quickly, Hb concentrations are as high as 20 g/100 ml (Pugh, 1959; Ronald *et al.*, 1969; Vallyathan *et al.*, 1969; Geraci, 1971). Values lower than in walruses characterize the *Otaridae* (Lenfant & Hubbard, 1967; Lenfant *et al.*, 1969, 1970; Kuzin, 1972).

RBC counts of walruses is minimal among the *Pinnipedia* (Sokolov, 1967; Lenfant *et al.*, 1970; present study). Generally all pinnipeds have low RBC values. Maximal RBC count occurs in the Family *Phocidae* (5 mill/mm<sup>3</sup>) (Lenfant & Hubbard, 1967; Ronald *et al.*, 1969; Lenfant *et al.*, 1970; Geraci, 1971; Greenwood *et al.*, 1971; Glazova, 1974). It is therefore possible to suppose that the subdivision of *Pinnipedia* into *Phocidae* which are excellent divers, and the pelagic *Otaridae* and *Odobenidae* finds its reflection in RBC number and Hb concentration. *Odobenidae* and *Otaridae* are morphologically related also (Schaffer, 1958).

The relatively great RBC diameter of pinnipeds is inversely correlated with low RBC number, as in other mammals. Tyler (1960) gives 9.0  $\mu\text{m}$  for crabeater seal (*Lobodon carcinophagus*) RBC diameter and Lane *et al.* (1972) cites 10.06  $\mu\text{m}$  for the southern elephant seal

(*Mirounga leonina*). The fact that the RBC diameter of 6 fetuses is almost identical to that of adult walruses (7.85  $\mu\text{m}$  vs 7.78  $\mu\text{m}$ ) is very interesting. In pups and subadults this value is slightly lower than in adults (Table 1) yet this may result from the small number studied. RBC diameter in the walrus seems constant, contrary to the condition in many smaller mammals (e.g. *Soricinae*; Wolk, 1974) in which RBC diameter decreases drastically during postnatal life. This fact may be interpreted in many ways. Szarski (1974) however hypothesized that the occurrence of larger erythrocytes in mammal embryos is a sign of the evolutionary past of these animals. In small mammals characterized by a high level of metabolism the phylogenetic decrease of erythrocyte size resulted in a greater blood efficiency. In big and torpid walruses there might be no such physiologic necessity and erythrocyte diameter remained unchanged.

It should be stressed that no significant differences exist between the blood indices of males and females, males having only slightly higher values (Table 1) even though sexual dimorphism is very distinct in walruses. Body length and especially the body weight are much greater in males ( $.001 < P < .002$ ;  $P < .001$  respectively). In northern fur seals (*Callorhinus ursinus*) Hb concentration and RBC number is nearly 10% greater in males than in females (Kuzin, 1972). Yet these differences are statistically insignificant too.

The inverse relation between body weight and Hb value of adult males (Fig. 2) seems ironic. Dominant males are characterized by great body weight (Miller, 1975) but dominants are also very placid during provocation and fight rarely. Most probably their activity is even less that of subordinate males. Their domination does not depend upon a greater metabolic rate.

Generally walrus blood morphology is characterized by features common to the blood of all pinnipeds, i.e., high Hb concentration, a relatively small number of RBCs of great diameter and volume, thus with a high MCH value (Lenfant, 1969). Higher MCH occur only in the Weddell seal (Pugh, 1959), in the northern elephant seal (*Mirounga angustirostris*) (Lenfant & Hubbard, 1967) and in the southern elephant seal (Lane *et al.*, 1972). These characteristics indicate large blood oxygen reserves of pinnipeds, presumably reflecting their diving habits.

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#### HEMATOLOGIA MORSA, *ODOBENUS ROSMARUS*

##### Streszczenie

U 62 morsów schwytanych w NW części Morza Czukockiego badano poziom hemoglobiny (Hb), liczbę erytrocytów (RBC), średnicę erytrocytów (RBC diam.), ilość hemoglobiny w krwince (MCH), liczbę leukocytów (WBC), szybkość opadania krwinek (SR). U dorosłych morsów parametry krwi są następujące: Hb —  $17.0 \pm 2.2$  g/100 ml; RBC —  $2.89 \pm 0.9 \times 10^6/\text{mm}^3$ ; RBC diam. —  $7.78 \pm 0.6 \mu\text{m}$ ; MCH —  $59.66 \pm 16.8$  pg; WBC —  $6244 \pm 266/\text{mm}^3$ ; SR —  $4.8 \pm 2.2$  mm/h (Tabela 1). Poziom hemoglobiny jest więc u morsa wyższy niż u pelagicznych *Otaridae*, niższy natomiast niż u znakomicie nurkujących *Phocidae*. Liczba RBC jest najniższa wśród płetwonogich i należy w ogóle do najniższych wśród ssaków. Czerwone krwinki są duże i bogate w hemoglobinę. Istnieje dodatnia korelacja między ciężarem ciała embrionów i osesków a ilością hemoglobiny ( $r = .797$ ) oraz wartością RBC ( $r = .958$ ) (Rys. 1). U dorosłych samców wykazano ujemną korelację między ciężarem ciała a ilością hemoglobiny ( $r = -.577$ ) (Rys. 2).