from the seal to be studied, the red cells were labeled using Cr^{51}, and the labeled red cells were administered intravascularly to the seal at onset of diving using a calibrated syringe. By following the dilution curve of the labeled red cells during the following diving a significant sequestration of blood from the circulation should become apparent after termination of diving by the appearance of a second dilution curve produced by the increase in circulating blood volume when sequestered blood is returned to circulation. Accordingly, blood samples were obtained via an extradural vein catheter at 2, 4, 6, 8, and 10 minutes of diving and 2, 4, 6, 10, 20, 40, and 60 minutes following completion of the 10 minute dive. The blood samples and an aliquot of the labeled red cells infused were counted using an auto-gamma counter.

The radioactivity dilution curve during and following diving was plotted to assess any difference in effective blood volume between dive and post-dive periods. The indicated increase in circulating blood volume after diving was less than 20% indicating that only a small volume of blood could have been trapped in small vessels by the arterial constriction that occurs with diving.

Equilibration of radioactivity had occurred by the 20 minute post-dive blood sample. Total blood volume was calculated using the radioactivity of the post-equilibration blood samples. Total blood volume was 127 ± 9 (S.D.) ml/Kg body weight. This value represents 12.7% of body weight and is somewhat lower than the value of 16% reported by Irving and co-workers (J. Cell. & Comp. Physiol. 20:189, 1942) using plasma volume methods. Red cell mass calculated from blood volume and h matocrit was 77 ± 6 (S.D.) ml/Kg body weight. These values for blood volume and red cell mass are in good agreement with the increased non-lung oxygen stores in the seal when compared to man (J. Clin. Invest. 46:1048, 1967 and Abstract #9, this bulletin issue).

It is clear that no complete sequestration of blood occurs in this animal during diving despite profound arterial constriction. It appears that the function of the large hepatic venous sinuses and extradural veins may be to act as reservoirs for that fraction of the blood volume which is no longer contained within the constricted arterial system.

1967 #26

BLOOD VOLUME OF THE DOGFISH (Squalus acanthias)

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Previous measurements of blood volume of the dogfish were performed using T-1824 (Physiol. Zool. 31:16, 1958). In general, methods using T-1824 give rise to blood volumes which are significantly greater than those found using red cell labeling (Blood and other Body Fluids. Biol. Handbooks, Wash., D. C. 1961, pp. 1-10). This report presents blood volume determinations in the dogfish using Cr^{51} labeled erythrocytes.

Blood was obtained from the catheterized dorsal artery of the dogfish and labeled with Cr^{51} (as $NaCrO_4$) via standard techniques. After the final wash, the cells were resuspended in dogfish Ringers and injected into the catheter via calibrated syringe. A small amount of Ringers was used to flush the catheter. Samples were drawn at timed intervals and 1 ml aliquots were counted using an auto-gamma counter. Equilibrium was obtained within 20 minutes of injection of labeled red cells. By determining the dilution of the tagged cells as measured in the 20 min-

ute samples the blood volumes were calculated. No radioactivity was noted in the urine.

Fourteen animals were studied, 10 females and 4 males, weighing from 1.4 Kg to 5.9 Kg.

Mean blood volume for the series was 58 ml/Kg ± 25 S.D. The range was 35-121. This is somewhat lower than the published value of 68 ml/Kg (31-109) utilizing T-1824 (Physiol Zool. 31:16, 1958).

1967 #27

ACID-BASE RELATIONSHIPS IN BLOOD OF Squalus acanthias: PRELIMINARY NOMO-GRAM

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To follow the general condition of experimental specimens a nomogram showing the inter-relationships of pH, pCO_2, and non-carbonic acids (NCA), in arterial blood was constructed. Fresh blood from two animals, hematocrit 21 and 23, was equilibrated in small tubes with 3.2, 4.06 and 6.22% CO_2 in oxygen at 30°C. The pH was read at 30°C using an Astrup micro pH electrode (Radiometer) (Ann. Surg. 156:138-46, 1962). Similar equilibrations were carried out with the same blood to which 10 mEq and 20 mEq/L of lactic acid has been added (reagent 500 mEq/L). Slopes and intercepts at 3 mm Hg pCO_2 were calculated for each of the six linear log pCO_2-pH curves obtained. The level of the NCA for each sample (1.5 to 26 mEq/L) was estimated. The NCA values were plotted vs pH at 3 and 30 mm Hg pCO_2. The value pH 7.78 ± 0.07 and pCO_2 3.07 ± 0.49 mm Hg, obtained by Murdaugh et al., was used as the normal (Bull. M.D.I.B.L. 6-25:28-30, 1966). The small enclosed square of the nomogram represents the "normal." Curves were fitted by eye and intermediate NCA values obtained.

The pH values of three samples of constant pCO_2 were measured at 15° and 30°C. For each degree C decrease in temperature, the pH rose only 0.0001 pH units. It was concluded that the nomogram could be used at any temperature provided data were obtained at the temperature of the fish.

The pH was obtained at various temperatures (11-37°C) for 11 blood samples with a constant CO_2 content. For each °C decrease in temperature, the pH rose 0.006 to 0.014 pH units (average 0.0080 ± 0.003). This correction should be applied to pH data obtained at a temperature other than that of the fish before the nomogram is used.

The nomogram is most easily used with the arterial pH and a second pH at a known pCO_2. An analyzed mixture of about 1% CO_2 in oxygen is convenient for equilibration. An accurately measured or calculated pCO_2, however, serves equally well as a substitute for the second pH value.

pH, pCO_2 and lactate values obtained by Murdaugh et al. (loc. cit.) appear to fit the nomogram satisfactorily which suggests that, for the struggling or caged fish, the increase in NCA is principally lactate (Table 1).

This nomogram has been helpful in following the decay of preparations of Squalus acanthias in the laboratory. The level of the NCA may correlate with activity, hypoxia, and with inadequacies of cardiac output as it does in man. It is possible, however, the NCA as well as CO_2 is excreted by the gills making a somewhat different interpretation of data necessary.