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 NOMOGRAM

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To follow the general condition of experimental specimens a nomogram showing the interrelationships 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.

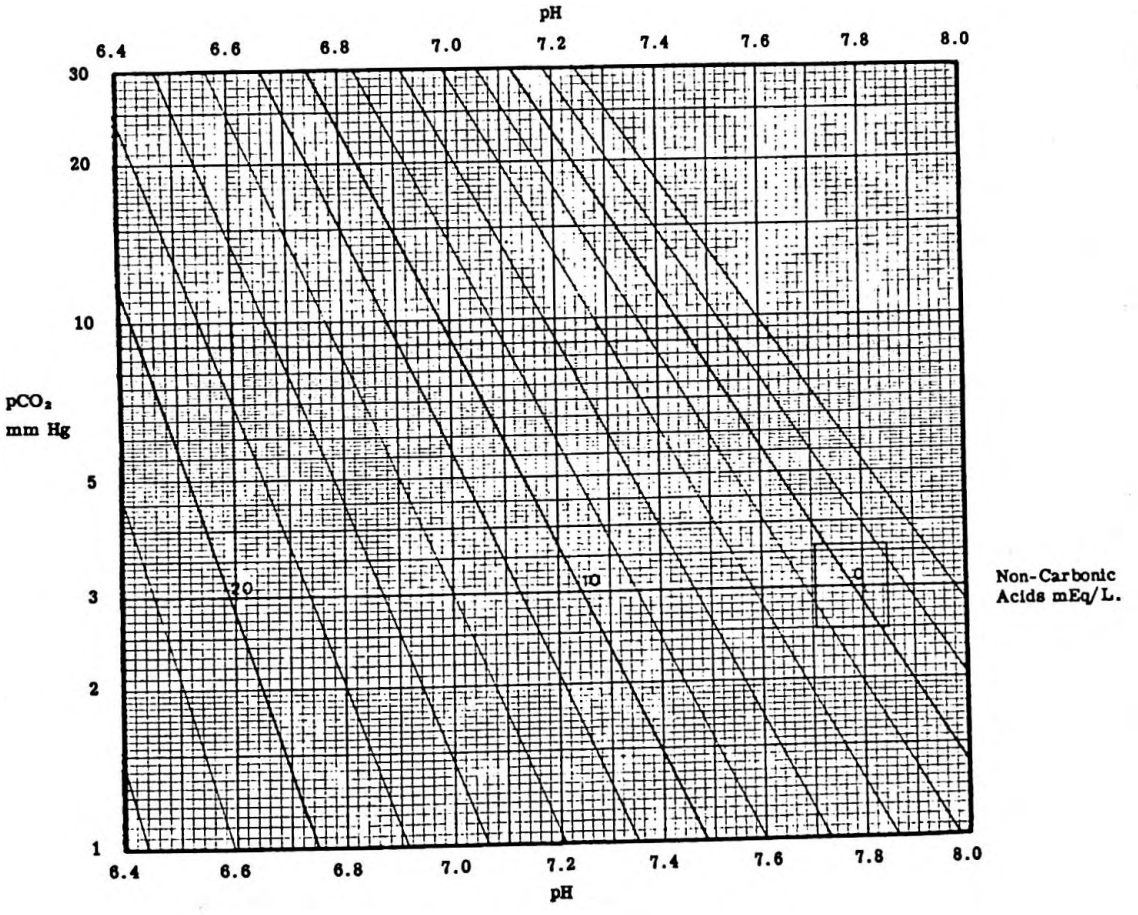
The nomogram is most easily used with the arterial pH and a second pH at a known pCO_2. An analyzed mixture of about 1% CO_2 in oxygen is convenient for equilibration. An accurately measured or calculated pCO_2, however, serves equally well as a substitute for the second pH value.

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.

Table 1

	Wild fish	Caged 3-9 days	Caught on trawl
pH	7.78 ± 0.07	7.76 ± 0.06	7.52 ± 1.00
pCO_2 mm Hg	3.07 ± 0.49	2.61 ± 0.62	2.90 ± 0.75
Lactate mEq/L	1.91 ± 0.63	4.08 ± 3.50	9.10 ± 5.30
Δ Lactate mEg/L (measured)		2.17	7.19
NCA mEq/L (from nomogram)		1.30	5.20



The slopes of the log pCO_2-pH curves varies from -1.52 for the NCA = 0 isobar to -3.13 for NAC = 20 mEq/L isobar. Corresponding slopes for human blood are -1.52 and -2.33. Under normal conditions, a given percent change in pCO_2 will produce a roughly comparable pH move in the two species. On the other hand, the buffering of NCA by human blood is approximately 3 times as effective. One mEq/L of added NCA produces a pH change of 0.05 units in blood of Squalus acanthias and only 0.015 units in human blood. Buffer values are lower for Squalus acanthias primarily because hemoglobin and plasma bicarbonate are lower.

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