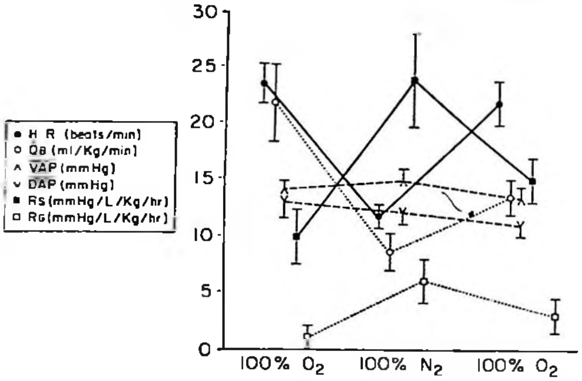
Oxygencontent and PO$_2$of both arterial and venous blood fell significantly as did the oxygen consumption. There was a statistically significant return of these values when the sea water to the animal was agin oxygenated. pH and PCO$_2$ did not change significantly during the period of hypoxia. With the fall in oxygen tension there was a sharp decrease in heart rate and cardiac output. Ventral aortic pressure, however, rose slightly, dorsalaortic pressure fell, and the gill resistance increased five-fold. There was also an increase in the calculated systemic resistance with hypoxemia. All these hemodynamic variables returned toward pre-hypoxic levels when the fish was returned to sea water equilibrated with 100% O$_2$. In the fish given atropine the changes in response to hypoxemia were abolished.

PaO$_2$(mmHg)	483±47	16±5	357±114
PvO$_2$(mmHg)	25±6	12±3	25±3
CaO$_2$(VOL %)	4.5±0.5	0.5±0.2	4.2±0.7
CvO$_2$(VOL %)	0.7±0.2	0.2±0.1	0.5±0.2
Vo$_2$(cc/Kg/min)	1.10±0.50	0.03±0.01	0.10±0.05
pHa*	7.37±0.10	7.41±0.10	7.45±0.05
PaCO$_2$*(mmHg)	5.1±1.0	4.8±0.6	6.2±1.9
PvCO$_2$*(mmHg)	6.7±1.3	8.9±1.5	9.6±1.1



*NO SIGNIFICANT DIFFERENCE BETWEEN 100% O$_2$ AND 100% N$_2$ VALUES WITH PAIRED T TEST

Vagally mediated bradycardia accompanying anoxia or hypoxemia is commonly observed in many species of lower vertebrates including dogfish. The change in pre-gill and post-gill pressures in response to hypoxemia are similar to those reported by Satchell (*J.Exp. Biol. 39:503, 1962*). The cardiac output values found furing equilibration of inspired sea water with 100% O$_2$ in this study are in agreement with those reported in the literature. The oxygen consumption values during 100% O$_2$ equilibration reported here are higher than those found in dogfish in sea water equilibrated with air (*J. Cell. Physiol. 67:93, 1966*). Since blood is only 85% saturated in free swimming fish (*Resp. Physiol. 1:13, 1966*) with PaO$_2$ of close to 100 mmHg, equilibration with 100%O$_2$ adds a significant amount of oxygen to the arterial blood. The dogfish is an oxygen uptake 'conformer" so an increase in oxygen delivery results in an increased oxygen consumption. The fall in cardiac output and the concomitant rise in gill resistance in response to hypoxia in this study are similar to the response to hypercapnia. In this study, however, there were no changes in pH or PCO$_2$. The pH values for this group of fish is low and the PCO$_2$ is elevated. If the response to hypoxia a hypercapnia are aditive then the excess acid and C might attenuate the observed response to hypoxem The response to hypercapnia, however, might secondary to hypoxia brought about by the effect of h CO$_2$ on the affinity of hemoglobin for oxygen. Since gill reflex response to hypercapnia is present in f equilibrated with 95% O$_2$, it is dobtful that hypoxia is necessary comonent of the response to hypercapnia. T similarity in effect of hypercapnia and hypoxia m indicate a common site of afferent stimulation like t peripheral or central chemoreceptors in mamma systems.

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Relationships Between Cardiac Output And Oxyg Consumption In *S. Acanthias*

Barbara Kent, Jean Francois Eid, Adrian Bryan-Bro and E. Converse Peirce II. Bronx Veterans Administra Hospital, Bronx, N.Y.; and Mt. Sinai School of Medicin New York, N.Y.

The dogfish *S. acanthias* belongs to a group o animals called oxygen "conformers" because oxyge consumption is dependent on the amount of availab oxygen. Oxygen availability is dependent on man factors. The rate of blood flow or cardiac outpu influences oxygen availability in two ways: a) by th amount of oxygen taken up in the gills; b) by the amoun of oxygen delivered to the tissue. In this study som relationships between cardiac output and oxygen consumption were determined.

Nine dogfish of either sex weighing between 1.5 an 6.0 Kg were prepared for measurement of cardiac outpu (Q$_B$) and oxygen consumption (VO$_2$) as described i report #25 of this bulletin. Fish were volume loaded wit 150cc dogfish Ringer's given in ten minutes into th caudal artery and bled by the same amount over a thirt

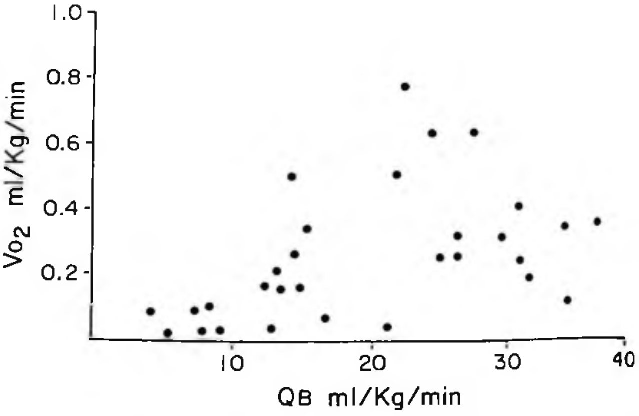
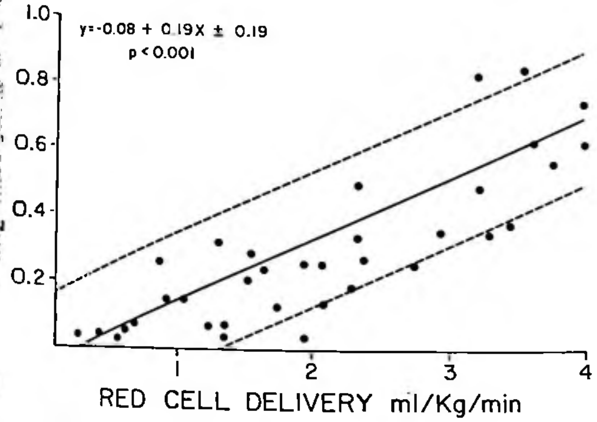


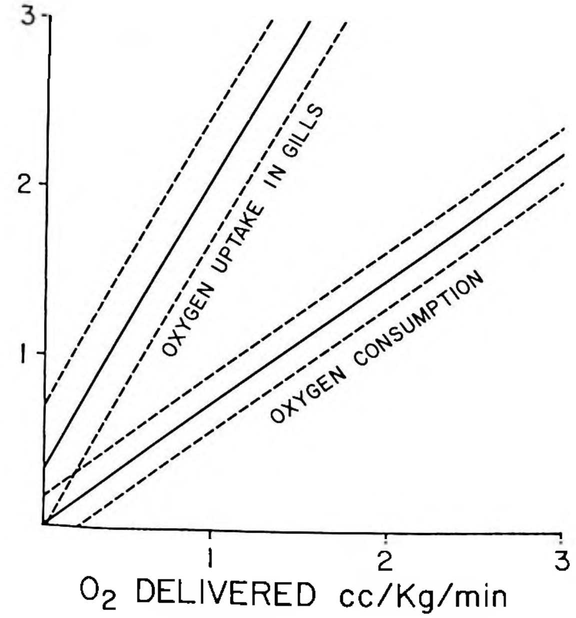
Figure 1. Cardiac output vs. oxygen consumption in 9 fish.

nute period. Cardiac output was recorded continuously nd arterial and venous blood samples for oxygen content etermination and hematocrit were taken at 15 minute tervals. VO_2 was calculated as $(caO_2\text{-}cvO_2) \times Q_B/100$.



gure 2. Cardiac output corrected for hematocrit vs. ygen consumption in 9 fish.

When thirty-six values of cardiac output from nine sh were compared with simultaneously measured ygen consumption no correlation was found (Figure 1). here was a significant correlation, however, between red ll flow rate (cardiac output corrected for hematocrit) d VO_2 (Figure 2). Figure 3 shows the correlation etween oxygen delivered to the tissues and oxygen nsumption. The least squares regression equation erved from these data is $y = 0.05 + 0.69x + 0.13$ where $y = VO_2$ (oxygen consumption), $x = caO_2 x Q_B$ and 0.13 is the standard error of the estimate (SEE). The oxygen uptake in the gills is shown on the same coordinate axis in Figure 3 and is described by the equation $y = 0.27 + 1.8x + 0.42$ where $y = VO_2$ (oxygen uptake in the gills, $x = cvO_2 x Q_B$ and 0.42 is SEE. Both correlations are significantly different from zero at p 0.001.



re 3. Oxygen delivered to the gills vs. oxygen uptake wn in steep curve; oxygen delivered to the tissues vs. gen consumption shown on lower curve. Least square ession lines calculated from 36 data point.

The high degree of correlation between oxygen consumption and oxygen delivery to the tissues shows the dogfish to be a true oxygen uptake conformer over a wide range of supplied oxygen. Oxygen consumption is independent of cardiac output which must be corrected for hematocrit in order to derive a meaningful relationship.

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Hyperbaric Experiments: A Test for Oxygen Sufficiency in *Squalus Acanthias* Gastric Mucosa in Vitro

George W. Kidder III, University of Maryland School of Denistry, Baltimore, Maryland

In the isolated chambered gastric mucosa of the dogfish, *Squalus acanthias*, diffusion of CO_2 into the tissue from the commonly-used 5% CO_2 supply is rate-limiting on the acid secretory rate. Use of 10% CO_2 gives a significant rise in rate and allows the development of a small potential difference (PD). (*Kidder, Bull. MDIBL 14:58, 1974*). This effect is also seen in the bullfrog gastric mucosa (*Kidder and Montegomery, Am. J. Physiol. 227:300, 1974*). One can calculate that in the frog tissue, diffusion of O_2 into the tissue should be sufficient for its respiratory needs, and experiments confirm this conclusion [*Kidder and Montegomery, Am. J. Physiol. 229: in press*). For the thicker dogfish gastric mucosa, with its unknown repiratory rate, it seemed possible that the diffusion of oxygen into the tissue from its supply concentration of 0.9 atm (10% CO_2/ 90% O_2 at atmospheric pressure) might be rate-limiting, with the resulting hypoxia contributing to low secretory rates and PD. This hypothesis has been experimentally tested.

A standard chamber system was used to mount a segment of dogfish gastric mucosa (stripped of superficial muscle) between two fluid-filled chambers (3.14 cm^2 exposed surface.) The fluids were those of Hogben (*Science 129:1224, 1959*) and approximate the ionic composition of dogfish blood. Carbachol (2.5×10^{-4} M) was added to the serosal solution as a secretagogue. The inlet and outlet ports of the tissue chamber were arranged for efficient mixing; circulation and aeration were by "air lifts" in the fluid exit lines. Acid secretory rate was measured by the pH-state technique, and PD by KCL/calomel electrodes in the fluid lines. Resistance was measured by passing a 20 uA current pulse via Ag/AgCl electrodes remote from the tissue, measuring the resulting voltage change at 1 sec. The input gas, either