Root effects. It is concluded that, given a peripheral receptor, oxygen affinity hypoxia may be a factor in triggering the gill reflex response to hypercapnia.

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HEMODYNAMIC RESPONSES TO VOLUME LOADING AND HEMORRHAGE IN *Squalus acanthias*

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Stressing the circulatory system by changing volume is one of the classic methods for studying circulatory control. Hemodynamic responses to large changes in volume were studied in *Squalus acanthias*.

Large female dogfish (4.8±1.2 kg) were placed in a trough in a sea water aquarium and their gills perfused with sea water (15°C) at 1 - 3 L/min. A #16 gauge needle was introduced into the caudal artery for measurement of dorsal aortic pressure and for injection and withdrawal of fluid. Heparin was given (1000 units/fish). Dorsal aortic pressure, sensed by a Statham P23"V" transducer, was recorded on one channel of a two-channel Beckman dynograph recorder. Heart rate was determined from recorder pressure peaks. The opercular opening rate was taken visually with a stopwatch. Blood samples (2 ml) were taken at 15-minute intervals for determination of hematocrit, P_{O_2} (Radiometer gas monitor and Clarke electrode) and pH (Radiometer pH meter and micro electrode). Time intervals for the experiment were as follows: (1) 15 minutes for stabilization and collection of control data; (2) 15 minutes for injection of 150 cc's of dogfish Ringers into the caudal artery; (3) 15 minutes for stabilization; (4) hemorrhage of 150 cc's of blood over 15-30 minutes. The fish were bled into a blood collection bag suspended from a Grass force-displacement transducer (FT03B) which gave a continuous recording of the weight of the bag on the second channel of the recorder. After the experiment the fish were sacrificed by section of the spino-medullary junction.

Volume loading caused no consistent hemodynamic response in dogfish. During the loading phase there was no correlation between volumes infused and heart rate and there was only slight correlation between volume in and blood pressure (see figure). The only significant difference was an increase in pulse pressure from 4.2±1.9 mmHg to 6.8±3.7 mmHg. The expected drop in hematocrit with volume loading is seen. The amount of Ringers solution infused was almost equal to the calculated blood volume of the fish (Bull. MDIBL 7:5, 1967). Hemorrhage caused definite immediate directional changes in all hemodynamic parameters measured. Systolic, diastolic, and pulse pressures dropped while heart rate increased. This was accompanied by an increase in both pH and P_{O_2} of arterial blood. The opercular rate was uninfluenced by changes in circulating blood volume.

The lack of increase in blood pressure with volume loading is consistent with the theory of little neurogenic control of the peripheral vasculature in dogfish. The increase in pulse pressure with little change in mean pressure indicates that vascular beds open passively to volume increase. The increase in heart rate is interesting. A reflex bradycardia linked to increase in pressure has been shown (Bull. MDIBL 9:18, 1969). Perhaps the tachycardia seen here with hypotension is a part of the same reflex. Heart rate may be controlled by a pressure dependent negative feed-

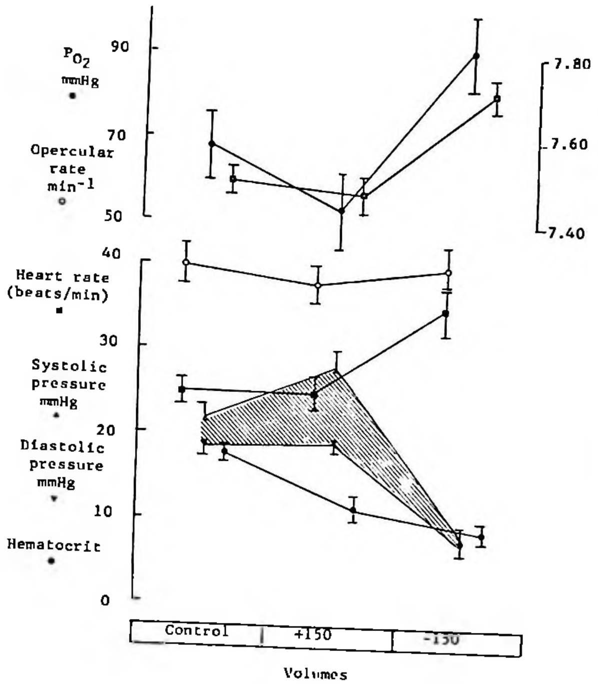

Figure: Hemodynamic and blood gas data shown for control, after infusion of 150 cc dogfish Ringers and after hemorrhage of 150 cc blood. the ventical bars represent standard deviation.

back control system, a system common in mammals. The observed rise in pH is not without precedent. Lowering cardiac output with MS222 was shown to gradually decrease the level of non-carbonic acids and lower the P_{CO_2} (Bull. MDIBL 7:47, 1967). Hemorrhage in mammals would be expected to cause a fall in pH. The mechanism by which dogfish responds by increasing pH will be an interesting question of study.

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