ilton-Stewart dye dilution technique was adapted permitting such measurements to be made in the seal. Fox green dye was used as an indicator dye, and an automatic recording continuous-flow photometer was employed to record the dye concentration curves in arterial blood. Validation of this technique was obtained by duplicate measurement of cardiac output by dye dilution and by direct Fick while the seal was breathing ambient air.

The results obtained were as follows. The cardiac output abruptly dropped at onset of diving from approximately 4 L/min to 0.4 L/min. This decrease was roughly proportional to the decrease in heart rate so that stroke volume did not change significantly. Dye injected into peripheral veins during diving did not appear in the central circulation or the arterial blood, indicating directly a cessation of blood flow in the flippers. With the termination of diving, heart rate and cardiac output returned at first to above basal values and then returned to basal values.

The rate of blood flow during diving is quantitatively consistent with myocardial plus cerebral blood flow. The restriction of blood flow to these organs permits O_2-dependent metabolism to continue in these key areas and thus permits survival despite loss of external O_2 supply.

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CARDIAC OUTPUT AND GILL GAS EXCHANGE IN Squalus acanthias

E. D. Robin, H. V. Murdaugh, Jr., J. E. Millen, E. Weiss, C. D. Hearn, and W. Drewry, University of Pittsburgh, Pittsburgh, Pa., and the University of Alabama, Birmingham, Ala.

A number of techniques have been employed to estimate cardiac output in fish. These techniques have been handicapped by two factors: (1) the lack of precise techniques and (2) the necessity for nonphysiological circumstances during the measurements. In the present studies these handicaps were overcome by modifying the Hamilton-Stewart dye dilution technique so that it could be applied to the marine elasmobranchs, Squalus acanthias.

A technique was devised which permits the insertion of a catheter in the dorsal aorta through a simple needle puncture. The precise identification of the location of the catheter could be validated by the O_2 content of the blood, the pulsatile nature of the blood flow, and anatomical identification by direct inspection after completion of the studies. This intra-aortic catheter permitted blood to be sampled at a rate consistent with the inscription of an accurate dye dilution curve. Venous injection of Fox green dye was accomplished by a single needle puncture through the skin into the ducts of Cuvier. Blood obtained from the ducts of Cuvier was considered representative of mixed venous blood. O_2 consumption and CO_2 production were calculated by multiplying appropriate arterial and venous differences by the cardiac output. RQ was calculated from these values. This technique allowed the studies to be performed with the fish virtually unrestrained and in approximately normal physiological status.

A total of 15 fish, weighing from 2.6 to 7.0 kg, were studied. The following data were obtained. Mean resting CO was 1.53 L/kg/hr. CO appears to be proportionally greater per unit weight in smaller fish. CO increases with increasing H_2O temperature up to 20°C, where CO falls. Basal oxygen consumption averaged 37.6 mM/kg/hr. CO_2 production averaged 28.7 mM/kg/hr. RQ averaged 0.92.