all well below what we have calculated by other methods as the potential equilibrium levels for these compounds in brain and CSF.

Urea, ethylene glycol, and thiourea are molecules of similar molecular weight but of differing lipid solubility, urea being the least lipid soluble and thiourea the most of these three. Equilibration of ethylene glycol between blood and tissue or CSF was essentially complete within four hours with the exception of skeletal muscle which again appeared to be more "impermeable" than the other tissues. For urea equilibration between blood and cardiac muscle was very rapid, being essentially complete in 30 minutes. Cerebrospinal fluid urea equilibration was complete in about one hour. Blood urea appeared to equilibrate with skeletal muscle in about 4 hours (distribution space = 90%) while cerebrum and medulla urea levels were still rising after 22 hours. The results with thiourea are very similar to those with urea except that CSF seemed to equilibrate more slowly with the plasma thiourea and skeletal muscle appeared to equilibrate more rapidly.

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RENAL HEMODYNAMIC VALUES IN THE SKATE (Raja erinacea)

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Except for the dogfish, Squalus acanthias, little or nothing is known about standard renal hemodynamic values in elasmobranchs that could be used for comparisons with the more extensively studied teleosts and other aquatic vertebrates. In the course of a series of environmental dilution experiments on the common small skate, Raja erinacea, several individuals turned up with plasma levels of p-aminohippurate (PAH) in a range appropriate for measuring minimal renal plasma flow (RPF) under control conditions and after adaption to 50% sea water. The essential findings on two of these are presented in Table 1.

Table 1

URINE VOLUMES, GLOMERULAR FILTRATION RATES, RENAL PLASMA FLOWS AND FILTRATION FRACTIONS IN SKATES MAINTAINED IN 100% AND IN 50% SEA WATER

Hours	ml per kg x hr			FF
	$\dot{V}$	GFR	RPF	
	1.13 kg skate in 100% sea water			
6.75	.26	.45	30.8	.015
6.15	.22	.40	34.3	.012
10.50	.19	.50	40.4	.012
	1.5 kg skate in 50% sea water			
3.25	2.06	5.80	67.0	.087
2.75	2.00	5.70	85.7	.067

The skate in undiluted sea water (1.3 kg) had 3 ml of an aqueous 5% inulin—2% PAH solution injected intramuscularly into 6 sites 18 hrs before the first collection period. Inulin plasma concentrations were 57.5, 53.0 and 48.0 mg% in samples taken at the midpoint of each clearance period. Corresponding PAH plasma concentrations were 1.15, 0.67 and 0.40 mg% respectively. The 50% sea water skate (1.5 kg) was similarly injected with 3 ml of an aqueous 3.3% inulin—3.3% PAH solution, and midpoint values interpolated from plasma samples taken at the beginning and at the end of clearance periods were 11.7 and 12.6 mg% for inulin, and 3.6 and 2.8 mg% for PAH. Blood samples were taken with a 20 gauge needle from the caudal vein close to the base of the tail. As with all elasmobranchs, skates have no urinary bladder. We were not successful in cannulating the ureteral aperture in female specimens, but in males the opening to the shallow urogenital receptacle was readily identifiable in the midventral wall of the cloaca just inside the powerful anal sphincters. It is possible to secure an indwelling polyethylene catheter in it using several separate sutures instead of attempting a standard continuous "pursestring" ligature. For further support the catheter was also secured with several ties through skin at the base of the tail, and a small toy rubber balloon was then attached for serial urinary collections.

Renal hemodynamic values in Squalus depend somewhat on conditions of capture and laboratory maintenance, but in most studies GFR varies between 2.5 and 5 ml per kg x hr (Silverman et al, Bull. MDIBL 6:36, 1966; R. P. Forster, in Sharks, Skates and Rays, Baltimore: Johns Hopkins Press, 1967, pp. 187-95). Corresponding GFR values are much lower in the skate and were found to average between 0.45 (Table 1) and 0.7 (Goldstein et al, Bull. MDIBL 8:29, 1968) in fish maintained under optimal conditions in 100% sea water. Hematocrits averaging 18% varied from 11-27%.

Renal plasma flows in the skate under control conditions average 35 ml per kg x hr. With an average GFR of 0.45 PAH/inulin clearance ratio is 78, and it appears that no more than 1.2-1.5% of the total plasma flowing through the kidneys is filtered at the glomeruli. On the basis of phenol red clearances it seems that in the dogfish no more than about 2% of the RPF is filtered (H. W. Smith, Physiology of the Kidney, New York: Oxford University Press, 1951, p. 180). These very low values for filtration fractions in elasmobranchs (20% in mammals) reflects the influence of the separate renal portal venous blood supply, the urea and trimethylamine oxide retention habits in the cartilaginous fishes and the possibility that, as in teleosts (R. P. Forster, J. Cell. Comp. Physiol. 42:487-509, 1953), at any given moment not all the glomeruli are being perfused with blood. Deetjen and Boylan's recent direct observations of adrenalin effects on the linear velocity and flow rates of tubular fluid in Squalus also support the view that renal blood flow rates may be augmented by the activation of previously resting glomeruli (Bull. MDIBL 8:16, 1968). Furthermore, our current finding that GFR rose as much as 10-fold after adaptation to 50% sea water (Table 1) suggests that recruitment of new glomerular activity occurred, rather than that any set of systematic hemodynamic factors had produced 1000% increases in the filtration efficiency of individual previously functioning glomeruli. The relatively small increase in renal plasma flow following environmental dilution, however, would suggest that the factors which presumably induced recruitment of glomerular activity were not correspondingly effective in increasing blood flow through the renal portal circulation.

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