

Antidiuretic Hormone Levels in Some Cetaceans¹ (35458)

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It has been demonstrated that renal function in cetaceans is far more labile than in most mammals (1). Following a meal of raw fish GRF, RPF, and urine flow increase manyfold over fasting values. In spite of the considerable postprandial increase in urine flow, urine osmolality is relatively stable. A situation obtains in that urine osmolality does not seem to vary inversely with urine flow rate. The factor responsible for these changes is not known. Although it has been proposed that these changes in urine flow do not depend on alterations in the ADH levels of plasma (1), no measurements of ADH were made. This work was done to test the hypothesis that the postprandial diuresis is not a result of changes in the concentration of ADH in plasma.

Materials and Methods. Five adult porpoises, *Tursiops truncatus*, and a young killer whale, *Orcinus orca*, kept at the Navy Marine Bioscience Facility were employed in these experiments. For urine and blood collection the animals were taken out of the water in transport slings and comfortably suspended in a specially constructed transportor that was equipped with a spray system for keeping the animals moist and cool. This setup for urine collection has previously been illustrated (2). A urinary retention catheter was inserted for monitoring flow rate and collection of hourly urine specimens for analysis.

All blood samples were collected from the central vessels of the tail flukes, quickly centrifuged, and the plasma was separated. Four vol of cold 10% trichloroacetic acid were added to each plasma sample, and the mixture was immediately frozen. The frozen samples were packed in Dry Ice and shipped by air to Ann Arbor for ADH analysis. Con-

centrations of ADH were estimated as previously described (3) using the method of Weinstein *et al.* (4) as modified by Share (5). This method is one which involves partial purification by column chromatography and concentration of the elute by evaporation. Since no ADH was detected in the plasma from our first experiments (20 ml of plasma), later blood samples were increased so that ADH from 50 or 100 ml of plasma was extracted for bioassay. The bioassay consisted of measuring the change in electrical conductivity of urine of a water loaded, ethanol-anesthetized rat in response to an intravenous test dose of plasma extract, and comparing it to the response elicited by injections of ADH standards.

ADH content of two pituitary glands was estimated by grinding the pituitaries in a cold solution of 0.03% acetic acid saline, with a siliconized glass homogenizer. The homogenate was treated in the same manner as plasma. As a check of the method, the pituitaries of 3 rats were treated similarly at the same time, and were found to contain 365 mU/gland, a value within the range of that reported by other investigators (6, 7).

Results. In Table I are presented the data for ADH concentrations in plasma, urine flow rate, and urine osmolality from 6 different animals fasted for 2.5 to 60 hr. In all but four samples no ADH was detected. Those samples listed as containing less than some value showed no ADH on bioassay. By injecting small standard doses of ADH into the assay rat, it was possible to determine the minimum response of each assay animal and from that value calculate the maximum concentration which could have been in plasma and yet remain undetected.

The samples which contained measurable concentrations of ADH had very low levels

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TABLE I. Plasma Levels of ADH, Urine Flow Rates, and Urine Osmolality in Porpoises Fasted for Varying Times.

Animal	Plasma (ml) used	Duration of fast (hr)	(ADH) _p (μ U/ml)	Urine flow rate (ml/min kg)	Urine osmolality (mOsm/kg of water)
Cynthia	20	3	<0.8	0.0297	1832
187 kg female	20	24	<0.8	0.0057	1804
<i>T. truncatus</i>	20	36	<0.8	—	—
	50	52	0.3	—	—
Wave	50	2.5	<0.6	0.0157	1536
183 kg (spayed) female	20	4	<0.8	0.0213	1458
<i>T. truncatus</i>	20	23	<0.8	0.0031	1494
	20	24	<0.8	0.0035	1566
Squinty	20	4	<0.8	0.0368	1902
133 kg female	20	23	<0.8	0.0075	1568
<i>T. truncatus</i>	20	24	<0.8	0.0087	1469
Shelob	50	3	<0.6	0.0165	1655
177 kg female	50	24	0.2	0.0042	1725
<i>T. truncatus</i>					
Peg	100	31	<0.2		Not observed
128 kg female					
<i>T. truncatus</i>					
Ahab	100	60	0.2		Not observed
2160 kg male					
<i>O. orca</i>					

compared to dog (3), rat (8), ewe (9) and man (10).

Fresh pituitary glands from two porpoises were removed for ADH analysis immediately after death. The first porpoise (a 136 kg female) drowned when it accidentally became entangled in a net underwater. The second animal (a 170 kg male) died from a cerebral hemorrhage. The two pituitaries had 17 and 37 U/gland. This is 46 and 100 times as much ADH as in a single rat pituitary. Since the weight of the rats was about 150 g, the porpoise gland contained considerably less ADH than would be expected on a body weight basis compared to rats. This is in agreement with the old observation of Geiling *et al.* (11). Although no data were given, they stated that antidiuretic hormone concentrations in the posterior lobe of porpoise pituitaries were low.

Discussion. From the present data, there appears to be no evidence that the porpoise controls the rate of urine formation by secretion of ADH. It should be pointed out that

the sole source of water for marine porpoises appears to be from its food. Following eating, urine flow rises to high values and declines with time. In most animals ADH was undetectable, and in those which had measurable levels it was considerably lower than that reported in other mammals dehydrated and fasted for this length of time. It is, of course, possible that the porpoise kidney is exquisitely sensitive to ADH and is able to respond to concentrations far lower than the kidney of other mammals. However, this would be a unique situation. In addition, ADH would have to affect the kidney somewhat differently, as a reduction in circulating levels of ADH would result in increased urine flow rate with little or no change in urine osmolality. What then is the mechanism by which the porpoise alters the rate of urine formation? This is still an unsolved problem. Whether the response is neurally or hormonally mediated is not clear, nor is it clear just what the stimulus is which is sensed following feeding. All that one can say at the present

time is that ADH does not appear to be involved in this response, nor does the porpoise seem to have any appreciable levels of ADH in its plasma. It should be pointed out that this is not totally unexpected since the porpoise, in its natural environment does not have access to fresh water and so is not exposed to large fluctuation in plasma osmolality occasioned by drinking.

Summary. The ADH concentration in plasma of cetacea was measured following a period of fasting from 2.5 to 60 hr. Although the urine flow rate decreased markedly with longer periods of fasting, it was not possible to demonstrate a correlation between urine flow rate and ADH concentration of plasma. This was due to the fact that all animals had either very low or undetectable concentrations of ADH in plasma. In addition, the amount of ADH in two porpoise pituitaries was considerably lower, on a body weight basis, than in rats. It was concluded that it is unlikely that ADH plays any significant role

in regulating urine volume in the porpoise.

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