Comparative Physiological Aspects of Solute Secretion by the Eccrine Sweat Gland of the Rat* (33411)

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The composition of sweat in an animal other than man was first reported by Brusilow and Munger (1) when they described the concentrations of electrolytes in sweat obtained from the sweat glands of the hairless footpad of the cat. Cat sweat was found to be a hypertonic solution with the following composition (meq/liter), sodium, 171; potassium, 23; chloride, 144. More recent studies (2) indicate that the bicarbonate and lactate concentrations are (meq/liter) 37 and 8, respectively. The comparative anatomy of the sweat glands of cat and man (3) revealed the cat gland to have a short, thin duct segment whose epithelial cells contain very few mitochondria. By contrast the duct in man is long and coiled and the epithelial cells have abundant mitochondria. It was also found (3) that the secretory coil of man and the cat were identical, both having "clear" (electron opaque) cells and "dark" (electron transparent) cells.

Based on these two studies it was concluded that the composition of cat sweat was representative of precursor fluid secreted by the secretory coil of man. It was further suggested that in man this hypertonic precursor fluid was modified by electrolyte reabsorption by the duct to produce hypotonic sweat.

It has been known for some time (4) that the albino rat has functional sweat glands located in the palmar and plantar eminences. A review of recent electron microscopic studies by Matsuzawa and Kurosomi (5) and Wechsler and Fisher (6) suggests that apart from myo-epithelial cells the secretory coil of the sweat gland of the rat has predominantly one cell type. There is some ambiguity however in the identification of the cell type in the rat but using Munger's (7) criterion (the presence or absence of intercellular canaliculi) it appears that the rat secretory coil has principally "dark" (electron transparent) cells with only occasional "clear" (electron opaque) cells, the latter containing intercellular canaliculi.

Because, as in the case of the cat, the rat gland has a rudimentary duct, determination of the electrolyte composition of rat sweat might describe the nature of the secretion of these presumed dark cells in the secretory coil.

Materials and Methods. White rats of the Wistar strain weighing 200 g were lightly anesthetized with pentobarbital. A small cylindrical well was placed over each of the two rear paws and sealed to the paw with a synthetic rubber polymer (Kerr's Permalastic, Kerr Manufacturing Company, Detroit, Michigan). After the paws were washed, rinsed, and dried the well was filled with mineral oil following which 0.1 ml of 0.2% mg/100 ml of pilocarpine nitrate was injected in the plantar eminences. Sweat emerged as single droplets from individual glands within several minutes. After a sufficient volume of sweat had been secreted (approximately 0.5 μl) the sweat was aspirated into a capillary tube filled with mineral oil. At no time was the sweat exposed to air thus eliminating the possibility of evaporative loss of water. Sweat was analyzed by the following ultramicro techniques. Osmolality was measured by the cryoscopic technique of Ramsay and Brown (8) and sodium and potassium by flame photometry by the method of Young and Schögel (9). Chloride was determined radiometrically in three animals. Two hr prior to sweat collection the animals were given 100 μCi of ^{36}chlor-

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TABLE I. Composition of Rat Sweat Compared to Plasma.

Plasma				Sweat			
Osmolality (milliosmoles/kg of H_2O)	[Cl]	[Na] (meq/liter)	[K]	Osmolality (milliosmoles/kg of H_2O)	[Cl]	[Na] (meq/liter)	[K]
287	102	140	3.8	395		23	142
287	104	136	4.2	415		35	142
287	105	138	4.0	445	72	35	160
290	107	136	4.0	413	81	41	156
287	100	138	4.2	375	86	28	148

ide intravenously. After sweat was collected the specific activity of the plasma chloride was measured in samples obtained from the aorta. The total plasma chloride concentration and the plasma and sweat ^{36}chloride concentration were determined as previously reported (1, 2). By assuming the specific activity of chloride in the sweat to be identical to that in plasma, the total chloride concentration in sweat was calculated. Plasma analyses of sodium and potassium were performed as described previously (1).

Results. Table I shows the results of sweat and plasma analysis in 5 rats. In all cases rat sweat is hypertonic to plasma as manifested by a sweat osmolality which is much higher than that of plasma.

The most striking finding is the extremely high potassium concentration in rat sweat associated with relatively low sodium concentration. A comparison of the sweat osmolality with twice the sum of the sodium and potassium concentrations suggests there are other solutes of significance in sweat of the rat. The low chloride concentration when compared to the cation concentration indicates that the major anions in rat sweat remain to be determined.

Discussion and Conclusion. The secretion of sweat containing a high potassium concentration by a sweat gland containing in its secretory coil presumably "dark" (electron transparent) cells suggests that this cell is responsible for the secretion of potassium in sweat. Extending this conclusion to the sweat of man and the cat it is possible to speculate that in these species where the secretory coil is a mosaic of "dark" and "clear" cells, potassium is a secretory product of the dark cells and sodium a product of the clear cells, the relative concentrations being a consequence of the frequency and activity of each cell type as well as the reabsorptive function of the duct in man.

Summary. Sweat obtained from the sweat glands situated in the footpad of the rat was found to be a hypertonic solution with the following concentration of electrolytes (meq/liter): potassium, 149; sodium, 30; chloride, 80. Based on the descriptions of the fine structure of the rat sweat gland it is concluded that the "dark" (electron transparent cells of the secretory coil of the sweat are responsible for the secretion of potassium in sweat.

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