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Water and electrolyte economy of desert  
Aboriginals and New Guinea Melanesians (U)

W. V. MACFARLANE

University of Adelaide S. A.

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Water and electrolyte economy of  
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W. V. MACFARLANE, M.A., M.D.

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Since earlier measurements on Melanesians in New Guinea showed a correlation between minimal European contact and low blood pressure, with low sodium:high potassium status of body fluids, an extension of these observations was undertaken. Groups of different economic background were studied as they adapted to European ways. Those on government salaries (hospital orderlies at Goroka and casual labourers in Madang) were contrasted with lowlanders of the Ramu River who had had contact with traders for about 60 years. These in turn were contrasted with Highland Chimbu on a cash crop economy, and with Tsenda people-shifting cultivators on the uplands of the Jimi River who have now had mission contact for three years.

In Madang a few workers supported the rest of the family groups. They had migrated from the Ramu River into the town and changed from a subsistence economy based on sago, to trade store dietary with a considerable content of sugar, salt, canned meat and bread. In the Ramu rain forest at Wotebu, sago, small fish, fruit and vegetables provided the staple but some trade salt and canned meat was available and had been used for many years. These people were tribal relatives of those in Madang. In the highlands at Goroka hospital orderlies are relatively well paid and live in European type homes on European types of food. The much more remote Tsenda people at Koinambe have virtually no money economy but trading Jimi axes had yielded funds for beads, lanterns, steel axes and salt. A mission has been flying in canned meat and the salt consumption has increased three fold since 1965 but is still low. The first observations were made in 1966 while electrolyte and blood pressure measurements were made again in 1967.

TABLE 1

MEAN URINE ELECTROLYTES

European contact and social status	Place	Na mEq/l	K mEq/l	K/Na	pH
Salaried	Goroka	172	58	0.33	
Casual labour	Madang	156	66	0.42	5.7
Trade 60 yrs	Wotebu	19	99	5.2	5.8
Cash crop 2 yrs	Pari	54	212	3.9	7.7
Subsistence + mission	Koinambe	27	224	8.3	8.3
European		180	70	0.35	5.7

TABLE II

SWEAT ELECTROLYTES

European contact and social status	Place	Na mEq/l	K mEq/l	K/Na	Na/K
Labour	Madang	37.3	11.0	0.29	3.4
Trade	Wotebu	14.7	13.7	0.94	1.1
Cashcrop	Pari	13.4	11.9	0.90	1.1
Subsistence	Koinambe	20.0	14.0	0.70	1.4
European		93	6.4	0.07	14.8

TABLE III

SALIVARY ELECTROLYTES

European contact and social status	Place	Na mEq/l	K mEq/l	K/Na
Salary	Goroka	7.6	22.4	2.9
Labour	Madang	10.6	23.8	2.2
Trade	Wotebu	10.9	23.6	2.1
Cashcrop	Pari	11.4	28.1	2.5
Subsistence	Koinambe	8.7	20.5	3.5

The concentrations of sodium in urine, sweat, and saliva were greatest amongst the people with most European contact (Table I). The K/Na ratios were reciprocal to the increment of both systolic and diastolic pressure above the level of 95/60, that characterises the unsophisticated adult population of the Highlands. In the Ramu River area (Wotebu) where long but not intense white contact has taken place the Na/K ratio and blood pressures were somewhat lower than those of the Madang/Goroka groups. With the lower levels of contact in Koinambe, blood pressures were almost as low as they were the year before although some increment in sodium consumption by the population as a whole had taken place.

The main differences between socio-economic groups in electrolyte status are illustrated in the Tables. Urinary sodium is higher and pH lower, the greater the contact with money and European ways of life. In general K/Na is likely to be proportional to aldosterone levels, and this appears to hold for urine but not so clearly for sweat or saliva electrolytes.

The urinary pH rises to 8.9 amongst sweet potato eating people (but is lower in sago-eaters of Wotebu). Urinary Cl (70mE/l) and PO<sub>4</sub> (30 mEq/l) provide only about one third of the anion needed to meet the cation excretion of Highland people. Bicarbonate is excreted with carbonate presumably, to satisfy the cation load. As money, salt and protein increase there is reduction of the urine pH.

In the sweat, potassium concentration is twice the European level and sodium one fifth, with the Madang wage-earners nearer to European than the Highland gardening groups. Adaptation to humid tropics by the Madang and Wotebu people seems less effective in changing sweat ratios than diet. The Pari and Koinambe groups live of course in a temperate climate around 1200 m altitude.

Saliva shows less acculturation change than the other fluids: but the Melanesian potassium levels are twice and sodium one third European. Milk from Highland mothers is in the low range of sodium concentration, but it is consistently low in potassium relative to Europeans. This interesting anomaly is not explained.

The renin activity (a measure of angiotensin production) of the plasma from members of all these groups was estimated. The activities were 2 to 3 times greater than those of Europeans regardless of whether the Melanesians had had much or little European contact. Temperate zone Europeans have a normal plasma renin range of 0.5 to 3.0 ng/ml/hr, while at Koinambe the average value of renin activity was 3.7, in Madang 4.2 and at Wotebu 6.9 ng/ml/hr.

In the Wotebu, Ramu River rain forest the subjects reached an average total body water of 68%, while Koinambe cultivators remained at 74% water content, a high level probably associated with sweet potato dietary.

The coastal people are exposed to humid heat and this may sustain renin output, possibly through circulatory stimuli. Renin activity of plasma could not readily be increased by the conditions either of sampling or of preservation of the plasma in dry ice. Renin concentration was found to have only slight relationship to sodium output in the earlier investigation.

There are two other anomalies. One concerns the rather poor relationship of renin concentration and aldosterone concentration in the blood if renin is producing angiotensin to release aldosterone (Table V). The second is that if renin and angiotensin are concerned in the control of thirst, there would be higher levels of water turnover than have been encountered amongst these people.

Water turnover is at the European level, around 60 ml/kg/24hr. With high renin concentrations and activity of the plasma of all the tropical Melanesians large water intakes might be expected if angiotensin affected thirst. Where these have, however, been measured, they have not been outside the European level, in fact these investigations began as a result of the suspicion that Chimbu people did not drink and had low water requirements.

TABLE IV  
POTASSIUM - SODIUM RATIOS AND ARTERIAL PRESSURE

	Urine		Sweat K/Na	Saliva K/Na	BP	European contact
	K/Na	pH				
Madang	0.4	5.7	0.3	2.2	127/71	++++
Wotebu	5.2	5.8	0.9	2.1	117/70	++
Pari	3.9	7.7	1.1	3.1	115/75	++
Koinambe	8.3	8.3	1.0	3.7	98/60	+
European NG	1.9	5.8	0.1	2.5		+++
European	0.3	5.3	0.2	0.6		++++

TABLE V  
ALDOSTERONE, ELECTROLYTES AND BLOOD PRESSURE

	Aldosterone ng/100 ml	Renin Concentration	Renin Activity	Urine K/Na	BP
Pari (cash crop)	9.9	12.1	-	5.2	115/75
Koinambe (subsistence)	23.2	12.0	3.7	33.8	98/60

There is thus evidence that exposure to money economy brings about changes in blood pressure, and with increase of salt intake, sweat and urinary sodium rises, while plasma aldosterone falls.

Salivary and milk electrolyte concentrations do not, however, change from their characteristic low sodium; high potassium status, nor is it easy to reconcile the renin activities with the amount of sodium available.

Locations and social groupings:

Goroka : Medical orderlies, sophisticated, salaried.  
 Madang : Poor labourers, some unemployed: in town from Ramu River.  
 Wotebu : Village people with long trade and missionary contact on the Ramu River.  
 Pari : Village now getting money from coffee and trade in Highlands  
 Koinambe : 3 years exposure to mission with some trade, little money  
 Coast : Madang  
 River flats : Wotebu  
 Mountains : Goroka - town  
                   Pari - distant village  
                   Koinambe - remote settlement

SUMMARY

Although the urinary electrolytes of Melanesians approach the European pattern amongst those able to buy European foods, the salivary and sweat electrolyte ratios remain displaced in the direction of high potassium, low sodium concentrations.

Arterial blood pressures show evidence of rising with European contact, and plasma aldosterone concentration falls. But renin activity is high in all Melanesian groups and not clearly related to aldosterone, sodium status, water turnover or blood pressure. Renin was at a higher level in the humid heat than in the cooler mountain regions.

WATER, ELECTROLYTES, HORMONES AND BLOOD PRESSURE OF MELANESIANS IN RELATION TO EUROPEAN CONTACT.

W.V. MACFARLANE, BETH HOWARD, B. SCROGGINS and S.L. SKINNER.

Waite Institute, University of Adelaide, South Australia.

Florey Laboratory, University of Melbourne, Victoria.

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13. ABSTRACT  
The indigenous foods of Melanesians in the New Guinea mountains were sweet potato, taro and fruits, with rare ceremonial pig feasts.  
  
Urinary and sweat sodium is low, and potassium high in these people, whose resting arterial pressure is below  $100/70$  and plasma aldosterone and renin is 3 to 5 fold higher than the European level. As cash crops, money economy and European foods become available the aldosterone falls, sodium excretion rises, and blood pressure rises. Reduction in potassium intake lowers the urine pH from 8.5 to 7.0. Plasma renin remains high, particularly in the coastal people, but the reason for this is not clear.  
  
Salivary and sweat electrolytes do not change greatly from high potassium - low sodium even though aldosterone concentration is low and sodium is plentiful in urine.

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