course, and recovery is usually rapid and complete, more so than in the case of either affection separately.

I desire to express my acknowledgments and thanks to Dr. T. R. Matthews for allowing me access to these cases, for eliciting histories, interviewing friends and relatives, and facilitating me in obtaining specimens for examination from the patients.

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YOUNG

THE METABOLISM OF WHITE RACES LIVING IN THE TROPICS

II. THE COMPOSITION OF THE URINE

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In the course of a study of the effects of a tropical climate upon a white working race, a number of urines have been analysed to ascertain whether they showed any marked variation in the quantities of constituents from those given in the physiological text-books as the average excretions for dwellers in a temperate climate.

Investigations on the urine of white men living in the tropics have previously been carried out by a few workers only, and these have been done mostly with the object of inquiring whether the changed conditions bring about an altered mechanism for regulating the thermal equilibrium of the body.

The only systematic work of any extent is that of Eijkman (1893), in Java, who estimated the calorific value of the food of nineteen Europeans, and drew up a balance sheet between the nitrogen of the food and that excreted in the urine and faeces. In the course of these experiments he analysed the daily urine of his subjects over a period of fourteen days.

A few workers have recorded the results of observations upon themselves made during a short visit to the tropics, and have compared these with figures obtained in Europe before or after their journey. Among these latter may be mentioned Schilling and Jaffé (Schilling (1909)), who compared the composition of the diet taken by themselves in Europe with that consumed during a short stay in West Africa; in addition they determined the nitrogen excreted in the urine and faeces in both places. Rancke (1900), Wick (1910), Glogner (1909), and a few others have also published the results of a few observations made on themselves.

The results have been recorded of the examination of the urine of a number of American soldiers serving in the Philippines, as well as of natives of these islands, but these observations have been mainly confined to volume and specific gravity (Chamberlain (1911)).

A certain amount of work has been done on the composition of the urine of native races in the tropics. Eijkman (1893) analysed the urine of a few Malays for comparison with his Europeans, whilst McCay (1912) has recorded observations on a large number of urines of Bengalis, and Aron (1909) has examined urines of natives in Manilla. More recently Campbell (1917) published the results of analyses of the daily excretion of a few native medical students in Singapore. In most instances it was found that the urines of natives showed marked differences from the European standards, thus, for example, the nitrogen was generally much lower, which may be accounted for by the native diets being generally poorer in protein, and richer in carbohydrate than the diet usually consumed by the white man.

The results of these previous investigations will be discussed in reference to those recorded in Townsville in the following pages.

In a previous publication (Young (1915)) the results were recorded of an investigation carried out in Townsville into the partition of nitrogen amongst the various nitrogenous constituents of the urine. It was found that the total nitrogen in the urine was somewhat low, but the proportions of this nitrogen in the individual compounds agreed approximately with those found elsewhere.

It is a common belief that in the tropics the excessive loss of water through the skin causes a corresponding decrease in volume of the urine, and that the continued passing of concentrated urine is responsible for a large amount of kidney disease. In the present

investigations, therefore, the main object has been to compare the concentration of urine with that found in Europe, and attention has been confined to the volume, specific gravity, total nitrogen, freezing point (osmotic pressure) and certain inorganic constituents.

METHODS

The following methods were employed in these experiments. The specific gravity was determined at 15° C. with a Mohr's balance, the total nitrogen by Kjeldahl's method, and the sodium chloride by Volhard's method, i.e. by adding a known amount of silver nitrate, filtering off the silver chloride, and estimating the silver nitrate left unchanged by titration with potassium sulphocyanide in presence of a ferric salt. The phosphate was determined by titration with a uranium solution. The freezing point of the urines was obtained in the usual manner.

The results are put together in the accompanying Table I, all the figures being obtained during the hot summer months. The subjects were drawn from various walks in life, and comprise persons doing laboratory work, a medical man in practice, a newspaper reporter, hospital wardsmen. several men doing office work in the city, a shop assistant and several labourers. The figures in the table refer to the whole urine passed in twenty-four hours, the subjects living on their ordinary diet.

As is well known, with a freely chosen diet considerable variations are observed from day to day in the quantity of the various substances excreted in the urine, so that no great accuracy can be claimed for a single twenty-four hours' sample. The following figures, however, were found for a number of persons of very different occupations, and it will be noticed that on the whole they vary from the usual standard in the same way, so that the average figures may be taken as an indication of the type of urine found in tropical Australia.

Subject	Volume c.c.	Specific Gravity	Total Nitrogen grams.	Grams: Sodium Total	Grams: Chloride per 100 c.c.	Freezing point degrees C.	P_2O_5 grams.
1 (a)	1116	1·016	8·7	6·14	0·55	1·028	...
(b)	1000	1·017	7·8	3·60	0·32	0·935	...
(c)	525	1·027	8·0	3·60	0·68	1·726	...
(d)	515	1·026	6·8	4·75	0·92	1·907	...
2 (a)	830	1·023	10·2	5·41	0·65	1·437	...
(b)	644	1·023	8·0	3·69	0·57	1·466	...
3 (a)	885	1·025	11·0	8·15	0·92	1·643	...
(b)	814	1·032	14·7	6·95	0·85	2·095	...
4 (a)	718	1·030	10·9	8·55	1·19	2·049	...
(b)	753	1·031	11·7	10·32	1·37	2·102	...
5 (a)	624	1·032	9·8	6·73	1·08	2·119	...
(b)	556	1·031	...	4·50	0·81	2·025	...
6	965	1·026	11·7	12·35	1·28	1·869	...
7	582	1·028	6·5	6·29	1·08	1·694	...
8	874	1·027	15·0	4·82	0·55	1·929	...
9	738	1·031	14·3	5·64	0·76	2·105	...
10	852	1·024	11·7	6·69	0·79	1·714	...
11	702	1·023	9·2	5·68	0·81	1·675	...
12	875	1·021	9·7	8·85	1·01	1·613	1·24
13	593	1·022	6·9	7·24	1·22	1·752	1·57
14	1390	1·023	15·6	15·37	1·06	1·748	0·81
15	634	1·031	11·6	5·41	0·85	2·259	2·61
16	905	1·027	12·7	8·94	0·99	1·970	2·24
17	920	1·020	8·9	7·65	0·83	1·581	2·06
18	688	1·026	10·8	6·03	0·88	1·987	1·34
19	655	1·025	8·7	5·59	0·85	1·511	2·04
20	375	1·018	3·1	2·95	0·79	1·360	0·57
21	718	1·026	9·6	6·78	0·94	1·925	1·86
22	1070	1·024	14·3	10·38	0·98	...	2·61
23	922	1·027	12·4	12·76	1·32	...	1·76
24	782	1·025	10·8	7·38	0·94	...	1·96
25	621	1·023	8·8	5·00	0·49	...	1·56
Mean ...	782	1·0254	10·4	7·0	1·13	1·761	1·73
Maximum ...	1487	1·032	17·3	15·4	1·39	2·259	2·61
Minimum ...	375	1·013	3·1	2·95	0·32	0·935	0·57

22, 23, 24 and 25 are the averages over one week in each case.

The figures given in the text-books (Starling (1912)) as the average for temperate climates are:—

	European	Townsville averages.
Volume c.c.	1500	782
Specific Gravity	1·014 to 1·020	1·0254
Freezing point	−0·87° to −2·71°	−0·935° to −2·259°
Sodium Chloride	15·0 grams	7·0 grams
Phosphate	2·5 grams	1·73 grams

When compared with these it is seen that the volume is very considerably lower, the average being only 782 c.c. per day. The gravity is correspondingly higher. The freezing points of the urines come in every case within the range given for temperate climates, the maximum being − 2·259° C. with a mean depression of 1·76° C.

The sodium chloride shows a very interesting difference. The quantity was in every case but one (No. 8) far below the European figures. The average amount passed was found to be only seven grams per day. When the actual concentration of this salt is considered it is seen that it is not very different from that found in temperate climates, namely about 1 or 1·2 per 100 c.c. The figures actually found vary from 0·32 to 1·39 grams per 100 c.c. with an average of 1·13. This small amount of salt in the urine is thus instrumental in maintaining the freezing point about the same as that found in Europe. The small total quantity of chlorides present in the urine may be accounted for by the excessive perspiration, and a quantity of sodium chloride being excreted in this way.

The amount of water and sodium chloride lost in the sweat

The quantity of water lost in perspiration in the tropics is very considerable. Eijkman (1893) estimated that in his subjects, laboratory workers, an average of 1730 c.c. was lost per day in the perspiration and from the lungs. This, however, seems a small amount for a man doing manual labour in a hot climate such as that of North Queensland, and where all the work is carried out by white people, who work mostly to the same hours as in a temperate climate, that is during the hottest part of the day. Hunt (1912) in a paper upon the effects of a dry hot climate upon the body, describes his experiences during a march in the Deccan in India, with the dry bulb temperature at 104° F., and states that none of his party consumed less than three gallons (13·6 litres) of water per day, a quantity which he considers as the minimum advisable. He states that even with this quantity of liquid the flow of urine was by no means free. Most of this water, therefore, must have passed out by the skin and lungs.

In a warm moist climate, where there is little evaporation, the slightest exertion causes profuse sweating, and this saturates and clogs the clothing, and thus further interferes with free evaporation from the skin. This induces further excretion of sweat, a sort of vicious circle is set up, and the body is not able to utilise the sweat economically. The result of an increased consumption of water is an increased perspiration, which adds to the discomfort, and it is only when a very large amount of water is taken that any marked increase in the quantity of urine is observed. In spite of this discomfort the slightest exertion causes an increased desire for liquid, and a large quantity of water is consumed, and thus a corresponding amount of water is excreted by the skin.

In some experiments carried out in Townsville the loss in body weight was observed during a brisk walk of seventy minutes at the rate of about four miles an hour, the thermometer at the time being 80° to 85° F. dry bulb, and 70° to 80° F. wet bulb. The loss of weight in some subjects reached as much as 1100 grams, most of which would be due to loss of sweat. Moreover, in these experiments only the water actually evaporated was determined, the subjects being weighed in their clothing, which was saturated with sweat, so that the total loss of water must actually have been much greater than this quantity.

Losses of water such as this must be quite a common occurrence with people doing manual labour in the tropics. In discussing this question with a local carpenter, the author was informed that in the workshop it is customary for the men—four in number—to fill in the

morning a large bucket, capable of holding nine to ten litres, with water, and from time to time during the day these men dip their pannikins into it and drink. The whole contents of the bucket are consumed during the day, and it generally has to be replenished before the day's work is over. In addition these men will drink a large amount of tea and other liquids outside and at their homes. The great bulk of this water must be excreted in the sweat. It seems probable, therefore, that with manual work at least four or five litres of water per day must be passed through the skin.

With four workers in the laboratory the amount of actual liquid taken in was found to average between three and four litres per day per man, whilst the average volume of urine passed was only 817 c.c.

In order to estimate the quantity of sodium chloride which may be removed from the body in the sweat, determinations of this salt were made in the sweat of two subjects. The sweat was collected in a room in which the air was practically saturated with moisture at 95° to 96° F. The body was well washed down beforehand, so as to remove all old sweat residues. Generally two samples collected at an interval of half an hour agreed well in the sodium chloride content, showing that under these conditions there was no concentration of sweat on the skin, and that the specimens represented a fair sample of the sweat excreted. The sodium chloride was estimated by a modification of Volhard's method.

With one subject, upon two occasions, samples of sweat were found to contain 0·36 and 0·31 grams of sodium chloride per 100 c.c. respectively. During the first experiment the subject lost 650 grams in body weight during an hour in the hot room. The loss in weight due to respiratory exchange* during this time, as

* The loss in weight due to the respiratory exchange was calculated in one experiment. The expired air was measured by breathing into a Zuntz meter and a sample of this air was analysed for oxygen and carbon dioxide. The subject breathed into the meter for five minutes just before going into the hot chamber, again after thirty-five minutes, and a third time after seventy minutes in the chamber. The volume of CO_2 evolved and oxygen absorbed in c.c. per minute reduced to N.T.P. were :—

	CO_2 evolved	O_2 absorbed
Before entering	197	216
After 35 minutes	294	327
After 70 minutes	311	375

An average of these rates over the whole time gives as a rough estimate 19 litres of CO_2 evolved and 22 litres of O_2 absorbed, i.e. a total loss of about 7 grams in weight.

well as the loss in water from the lungs with the inspired air saturated at 96° to 97°, may be neglected, so that the loss of weight represents loss by sweat. The sodium chloride excreted in the sweat during this time was thus 2·34 grams.

Samples of sweat from a second subject were collected under the same conditions, and were found to contain 0·22 grams of sodium chloride per 100 c.c. During the hour and a half which the subject spent in the hot chamber, he lost 2,000 grams in weight, corresponding thus to 4·4 grams of sodium chloride from the skin. In another experiment on this subject the sweat was found to contain 0·11 grams of sodium chloride per 100 c.c.

Hunt (1912) found that his sweat contained 0·18 to 0·20 grams per 100 c.c., and he obtained higher figures (0·4) with other subjects. The quantity of sodium chloride excreted in the sweat may therefore be taken as from 0·1 to 0·4 grams per 100 c.c. A daily loss of sweat of several litres would, therefore, correspond to a good many grams of sodium chloride, and the deficiency of this salt in the urines under examination (7 grams instead of 15) may easily be accounted for by increased excretion by way of the skin.

The fact that so much sodium chloride is excreted in the sweat does not mean that the kidneys are relieved of any work, but rather the other way, since this salt after passing from the blood through the glomeruli of the kidney must have been subsequently reabsorbed in the tubules of that organ.

The phosphates

The quantity of phosphates expressed as phosphoric acid averaged 1·73 grams per day with a maximum of 2·61 and a minimum of 0·57. The normal figure given by the text-books is 2·5 grams, so that the phosphate was slightly lower than the standard. The concentration of phosphate was, however, much higher than the standard, 0·25 grams per 100 c.c. as against 0·17 grams. In samples of urine collected here, it is a common thing for phosphates to separate out within a very short time after the urine has been passed, and in many cases the urine is actually voided in a cloudy condition, which is due to precipitation of the phosphates, since it clears at once upon the addition of acid.

The total nitrogen

The urines examined in Townsville gave an average daily figure of 10·4 grams of nitrogen. Considerable variations were found in the same individuals at different times. In the following table are seen the daily averages of the nitrogen secreted by four persons over different periods:—

Subject	Date	Days	Volume	Specific Gravity	Nitrogen
1	March, 1913	9	986	1·026	11·7
	December, 1913	8	772	1·030	11·6
	February, 1914	7	1070	1·027	14·3
	January, 1915	7	849	1·026	12·4
	Average ...				12·1
2	September, 1914	4	922	1·029	12·4
	January, 1915	4	735	1·030	11·2
	Average ...				11·8
3	March, 1913	7	621	1·026	8·8
	January, 1915	7	946	1·025	7·8
	March, 1917	7	667	...	9·2
	Average ...				8·6
4	April, 1914	7	782	1·025	10·8
	January, 1917	4	737	1·023	9·1
	Average ...				10·1

Although in these four cases the average nitrogen differed fairly considerably from time to time, yet in general it was markedly lower than the European average, the mean of all four persons being 10·6 grams per day.

The figures all point to the fact that the nitrogen is below the European standard.

Urines collected during the cool season

Northern Australia has a hot and a cool season, and during the latter (May to October) very different climatic conditions are observed, the wet bulb thermometer is much lower and occasional spells of what is felt by the inhabitants to be cool weather are experienced. A few urines have been collected during this season for comparison, and these are given in the table below, the numbers being the averages of urine collected for several days.

TABLE II.

	No.	Volume c.c.	Specific Gravity	Total Nitrogen grms.	NaCl. grms.	NaCl. per cent.
	1	1437	1·017	12·1	...	...
	2	1237	1·021	11·7	...	...
	3	1372	1·012	10·5	...	...
	4	1367	1·014	11·2	...	...
	5	1214	1·016	9·5	9·87	0·81
	6	1912	1·016	14·5	9·95	0·52
	7	1766	1·018	7·9	8·24	0·72
	8	1441	1·020	9·4	13·58	0·97
	9	878	1·027	10·2	9·15	1·07
	10	1151	1·015	9·7	5·86	0·48
Average	5-10	1357·5	1·0187	10·2	9·44	0·77
Same subject hot Season		770	1·0257	9·95	6·55	0·86

These figures show a decidedly larger volume and smaller gravity than those obtained in the hot season, whilst the sodium chloride is larger in amount, but less in concentration. The urines of the last six subjects are averaged separately in the table for comparison with those of the same subjects during the hot season.

DISCUSSION

The records in the literature of the composition of the urine passed by the white man in the tropics are not very plentiful, and often contradictory in the results obtained.

Eijkman (1893) found that his nineteen European subjects in Java over fourteen days gave the following daily averages:—

Volume 1,442 c.c., specific gravity 1·017, nitrogen 13·04 grams. These urines, therefore, did not differ to any marked extent from those found in Europe as regards concentration, volume and nitrogen. Other workers have recorded the results of observations on themselves. Thus Plehn (1908) in West Africa found that his urine had an average daily volume of 1,075 c.c., and a specific gravity of 1·025, whilst Glogner (1909) found the volume practically identical in Sumatra and Berlin.

Neuhaus (1893), during a journey round the world in 1893, tested the average volume and gravity of the urine which he passed daily at various places during his journey. In the tropics the volume varied from 1,100 to 1,200 c.cs., and the specific gravity from 1·029 to 1·033, whilst outside the tropics the volumes ranged from 1,353 to 1,609 c.c., with a gravity of 1·021 to 1·023. His urine was thus more concentrated in the hotter parts of the world.

Chamberlain (1911) took the gravities of single specimens of urine of five hundred and ninety-six soldiers in the Philippines upon two occasions at a year's interval, and he obtained the figures 1·099 and 1·097. He concluded that the urine was therefore little different in gravity from that found in a temperate climate.

In a recent research Campbell (1917) found that his own urine in Singapore conformed in volume and gravity to the European standard, being 1,560 c.c. and 1·012 respectively. It is noteworthy in the last instance that the sodium chloride content averaged only 8·10 grams, or 0·52 per cent.

When the averages found in Northern Australia are compared with the figures quoted above, it is seen that they differ in that the volumes obtained elsewhere were much higher than those recorded in Australia, whilst the specific gravities were generally lower.

A comparison of the nitrogen with that found in Europe and by other workers in the tropics shows also certain differences. Our ideas of the metabolic changes which the protein taken in the food undergoes in the animal body have altered considerably in the last decade. The modern view assumes that the proteins are broken down by the digestive enzymes of the intestines into their constituent amino acids, which are then absorbed. The greater part of these are denitrified, the bulk of the nitrogen being quickly eliminated in the urine as urea. A small portion goes to make good the wear and tear of the tissues. The nitrogen in the urine represents, therefore, mainly the substances produced directly from the proteins of the food (exogenous metabolism, Folin), which vary in quantity with the amount of food taken. In addition it contains the nitrogenous substances such as creatinine produced by metabolism of the tissues (endogenous metabolism, Folin), which, according to Folin, are not materially different in quantity whether the diet is rich or poor in protein. The nitrogen in the urine is not an accurate measure of the quantity of protein metabolised, since a certain quantity is excreted into the intestine and passes out with the faeces, a certain quantity may be retained in the body, and a small amount is also lost in other secretions of the body such as the sweat. Still the total nitrogen in the urine may be taken as a rough indication of this protein.

In ordinary life when an indiscriminate diet is consumed, naturally great variations occur from day to day in the quantity of nitrogen passed in the urine, but the average figure as given in the text-books on physiology for temperate climates is about 15 or 16 grams of nitrogen per twenty-four hours.

Pflüger and Bohland, and Bleibtreu and Bohland (quoted by Eijkman) give rather less than this, namely 12·67 and 14·93 grams per day.

With regard to the nitrogen in the urine of white people in the tropics, Eijkman found that the urine of his nineteen European subjects on an ordinary mixed diet contained a daily average of 13·04 grams. He concluded, therefore, that an acclimatised European in the tropics passed as much nitrogen in his urine as he did in Europe.

Schiller and Jaffé (Schilling (1909)) during a short visit to West Africa, carried out experiments on themselves, and compared these with observations made in Europe before and after their journey. They found that in both parts of the world nitrogen equilibrium was approximately maintained on 17 grams of nitrogen a day, so that no appreciable difference was observed in the urine nitrogen.

Similarly Campbell (1917) in Singapore found that his own daily urine contained on the average 15·3 grams of nitrogen, similar again to the European standard.

These results would indicate that the quantity of protein required in the tropics is not different from that consumed elsewhere, and in fact Eijkman's analyses of the food eaten by his subjects, conformed in every respect to the usual standards. A similar conclusion was also arrived at by other researchers.

On the other hand Ranke (1900) published a comparison of his own diet during a visit of a few months to Brazil. This diet showed that although the protein was not much different, yet the total calorific value was much less in the tropics than in Europe. Glogner explained Ranke's observations as probably due to a loss of appetite, which he states is a common experience during the first period of residence in the tropics, and he concluded that Ranke had not resided in the tropics long enough to have passed this stage.

With regard to the nitrogen in the urines analysed in Townsville the average obtained was very much lower than that of the European text-books, and did not agree, therefore, with the results recorded by others in the tropics.

A certain difference in the nitrogen might be expected in a hot climate, on account of the larger quantity of water excreted by the skin, which takes with it a small quantity of nitrogen. Eijkman found the nitrogen lost in this way by Malays to be about 0·76 to 1·36 grams, and he estimated that Europeans in Java lost about 1·6 grams per day.

Benedict (1906), outside the tropics, found that during rest the nitrogen secreted in the sweat was approximately 0·071 grams per day, but during muscular exercise he found as much as 0·13 to 0·22 grams per hour.

In experiments carried out in this laboratory and already referred to, samples of sweat were obtained and determinations were made of the nitrogen in them. This was found to be 0·040 and 0·057 grams per 100 c.c. upon two occasions in one subject, and 0·033 and 0·030 grams per 100 c.c. in the other; the two subjects thus lost only 0·26 and 0·66 grams of nitrogen respectively during an hour in the hot chamber.

Allowing a man to lose from three to four litres of water a day by way of the skin, this would only account for a daily loss of 1 to 2 grams of nitrogen by this means. If this be allowed for it would bring the average nitrogen to from 11 to 12 grams per day.

and a further allowance of 10 per cent. lost in the faeces would bring the total to about 13 to 13·5 grams, which, taking the higher figure, corresponds to about 87 grams of protein, a figure still below that usually accepted as a standard (viz., about 100 grams (Voit)).

Eijkman found that his subjects in Java consumed on an average 99·6 grams of protein, of which 88·2 grams were actually absorbed, the rest being lost in the faeces. Taking Eijkman's average figures for nitrogen in the urine, 13·04 grams, and making the above allowances for sweat and loss in the faeces, it works out at about 101 grams protein per day, a number in close agreement with that found. It would appear, therefore, that with the subjects experimented on in Townsville the protein actually katabolised was less than that found by Eijkman in Java.

When an explanation is sought for these different results, a possible one suggests itself in the different conditions under which life is carried on in the Australian tropics. Eijkman's subjects, for example, were living in Java, where cheap native labour is to be obtained in abundance, and it is the rule to rest during the early and hot portion of the afternoon. In Queensland, on the other hand, as has been pointed out already, work is carried on by white people, and it is the exception to rest during the hotter hours of the day.

The results of examinations of the urine of native races in the tropics show differences from that of white people. As a rule, the native consumes less protein and more carbohydrate than the white man, and as might be expected, therefore, the urines are lower in nitrogen. Eijkman found that the daily urine of thirteen Malays gave an average of only 8·08 grams of nitrogen. Campbell, for native medical students in Singapore, obtained figures varying from 6·64 to 9·25 grams of nitrogen per day. On the other hand, Aron, in the Philippines, found a higher number, the nitrogen in the daily urine of the Philippino being stated to vary from 10 to 12 grams.

McCay (1912) has made a large number of observations upon the urine of Bengalis in India, and has compared them with the standards for Europeans. Very decided differences were found to exist, as is seen in McCay's table which is given below. However, if the Townsville urines be placed side by side with this table, the differences from the European standards are almost as striking for

some constituents as those given for the Bengalis.* The urea and sulphate given below were obtained from five people, and are the daily averages for a week in each case.

TABLE III

	European	Bengali	Townsville
Volume c.c.	1440	1200	784
Specific gravity	1020	1013	1025
Urea grams	35	13	20·7
Total nitrogen grams ...	18	6	10·4
Freezing point	−2·5° C.	−1·24° C.	−1·76° C.
Chlorides grams ...	15·00	10·00	7·53
Phosphates grams... ...	3·50	0·98	1·73
Uric acid grams	0·75	0·45	0·48
Sulphates grams	2·50	1·88	2·01

The average daily excretion of nitrogen found in Townsville (10·4 grams) may be compared with that obtained by Chittenden (1911) from one hundred and eight university students in the United States, the average daily nitrogen in the urine being 12·87 grams.

It is interesting also to compare the samples for one week obtained from four men doing laboratory work in Townsville with those averages given by Hamill and Schryver (1906) for seven men doing similar work in the laboratory of University College, London.

	Weight kilos	Total N. grams
1	67	14·3
2	61	12·4
3	63	10·8
4	48	8·8
Average	59·8	11·6
Schryver and Hamill	[illegible]	[illegible]

Although the average nitrogen is actually less in Townsville, yet when considered per kilogram of body weight the figures are practically the same (0·194 and 0·186 grams), and both correspond to an amount of protein very much below what used to be considered as the daily standard (approximately 100 grams of protein), even when all due allowances are made for the nitrogen lost in the faeces.

ALBUMINURIA

It has frequently been stated that the higher concentration of the urine in the tropics causes a greater amount of kidney disease than is found in temperate climates; moreover, in the opinion of many medical men in Northern Australia, a greater incidence of kidney troubles is found there. As reliable figures to test this could not be found, an attempt was made to obtain some indication by ascertaining the prevalence of albuminuria in Townsville.

A number of samples of urines from out-patients of the General Hospital were collected and tested for the presence of albumin. In no case did the subject show any other clinical symptoms of kidney trouble. The tests employed were the boiling test, the salicyl sulphonic test and the ferrocyanide test, and no urine that did not give all these tests was accepted as definitely containing albumin. The urine from six hundred and sixty-three patients was examined, including three hundred and sixty men and three hundred and three women, and a positive reaction was obtained in fifty-seven cases, forty-two of them being men and fifteen women. This would correspond to a total percentage of 8·6; amongst the men the percentage was 11·7, and amongst the women 4·9.

No attempt is made to draw any conclusions from these figures, but it is thought of interest to put them on record. The much higher percentage amongst men than women is worthy of note, nineteen out of forty-two of the cases in males being in men above the age of forty years.

SUMMARY

The twenty-four hours' urine collected from a number of persons living in North Queensland and of different occupations was analysed. The daily volume was very much less than the European standards given in the text-books, the average volume being only 784 c.c. This volume was increased considerably in the cooler weather.

The specific gravity was very much higher, whilst the freezing point did not differ very much from that found in Europe, thus the osmotic pressure was not very much higher.

A striking difference was noticed in the quantity of sodium chloride excreted in the urine, which was very low, and this may be accounted for by the large loss of water in the sweat which carries with it this salt. It is calculated that a man doing manual labour in the tropics must lose several grams of sodium chloride per day through the skin, which would readily account for the deficiency in the urine.

The total nitrogen showed a lower figure than that found in Europe, which cannot be accounted for by loss of nitrogen from the skin, since it is shown that this can only amount to 1 or 2 grams per day under normal circumstances.

These results differ from those obtained by Eijkman and other observers in other parts of the tropics.

An examination of the urine for albumin of persons not showing any other symptoms of kidney disease showed a high percentage of albuminuria, which was more marked in men than in women.

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ON THE ENDEMIC TSUTSUGAMUSHI DISEASE OF FORMOSA

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PLATES VIII AND IX

I. INTRODUCTION

In the Karenko District of eastern Formosa there is endemic in certain localities an exanthematous fever. Attention was first called to it in 1908 by its prevalence among the police engaged in building guard-lines against the savage Batran tribe of the Mokkui valley. Hence the disease goes by the name of 'Batran or Mokkui fever,' and is also called 'Horin fever,' as it frequently affects people who enter the virgin forests adjoining the village of Horin. Further, of recent years the fever has appeared among inlander* immigrants in the Yoshino, Toyoda, Hayashida and other plantations, where a number of people fell victims to the disease.

During the summer campaign of 1914 against the Taroko head-hunters of East Formosa, while acting as chief Medical Officer, I was able to examine minutely cases of the fever occurring chiefly in the Mokkui valley. My observations made it clear that the fever, which was always accompanied by swelling of the lymphatic gland system was analogous to the Tsutsugamushi or Kedani disease well known in the northern districts of Japan proper. I afterwards made more detailed investigations and laboratory experiments by permission of the Chief of the Commission devoted to the Study of the Endemic and Epidemic Diseases in Formosa, and the essential features of my five reports on the disease from 1914 to the present time are summarized in the present paper, in which I use the familiar term 'Tsutsugamushi disease' though originally

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