proximate quantitative values of the shearing-forces and bending-moments obtained for the three ships, 'Minotaur,' 'Bellerophon,' and 'Victoria and Albert':—

	'Minotaur.'		'Bellerophon'		'Victoria and Albert.'	
	Shearing-force. Displacement.	Bending-moment. Displace. × length.	Shearing-force. Displacement.	Bending-moment. Displace. × length.	Shearing-force. Displacement.	Bending-moment. Displace. × length.
In still water	$\frac{1}{22}$	$\frac{1}{88}$	$\frac{1}{33}$	$\frac{1}{176}$	$\frac{1}{16}$	$\frac{1}{139}$
On a wave-crest	$\frac{1}{7}$	$\frac{1}{28}$	$\frac{1}{13}$	$\frac{2}{97}$	$\frac{1}{11}$	$\frac{1}{43}$
In a wave-hollow	$\frac{1}{14}$	$\frac{1}{53}$	$\frac{1}{11}$	$\frac{1}{43}$	$\frac{1}{6}$	$\frac{1}{23}$
Supported at the extremities.	$\frac{1}{2}$	$\frac{1}{7}$	$\frac{1}{2}$	$\frac{1}{7}$	$\frac{1}{2}$	$\frac{1}{6}$
Supported at the middle	$\frac{1}{2}$	$\frac{1}{10}$	$\frac{1}{2}$	$\frac{1}{10}$	$\frac{2}{5}$	$\frac{1}{12}$

February 16, 1871.

General Sir EDWARD SABINE, K.C.B., President, in the Chair.

The following communications were read:—

I. "On some of the more important Physiological Changes induced in the Human Economy by change of Climate, as from Temperate to Tropical, and the reverse" (concluded)*. By ALEXANDER RATTRAY, M.D. (Edinb.), Surgeon R.N., H.M.S. 'Bristol.' Communicated by Mr. BUSK. Received January 6, 1871.

IV. *The influence of Tropical Climates on the Kidneys and Skin.*

None of the organs of the body are more visibly affected by great changes of climate than these, and their secretions, the urine and perspiration. As with the lungs† and other internal viscera, the congestion of the kidneys lessens, while that of the skin increases, when the blood is attracted to the surface by heat. The reverse happens when it is driven inward by cold. This involves their special and vicarious, waste-product and water-excreting functions alike. In the tropics the skin doubtless excretes much of the water thrown off by the kidneys and lungs in colder regions, as well as the nitrogen and carbon of the former, and carbonic acid of the latter. The elimination of surplus water, one of the most important uses of all of the four great depurating organs, is largely effected by these two. Their intimate relation in this office in cold latitudes is already known. We shall here attempt to show what it is in the tropics.

* Continued from Proceedings of the Royal Society, June 16, 1870, vol. xviii. p. 529.

† Ibid. p. 523.

The following experiments were made on myself (æt. 39), on a voyage from England to Bahia (lat. 11° S.), between June and September 1869. During 24 days, from Plymouth to the thermal Equator, drink (tea or coffee) being limited to 39 oz. daily, the urine gradually decreased from 39 to 30 oz., which merely proved that in semitropical, as in temperate climates, free fluid is chiefly thrown off by the kidneys, and that this diminishes as the heat increases.

The following Table gives the results of the two subsequent days, while passing through the equatorial doldrums or greatest heat, the drink being suddenly increased to 88 oz. daily :—

TABLE I.—To show the Urine excreted at the Equator.

Locality.	Average temp. F.	Date.	9 A.M. Night urine.		9 P.M. Day urine.		Totals.	
			Quantity.	Sp. gr.	Quantity.	Sp. gr.	Quantity.	Sp. gr.
Equatorial doldrums off the African Coast, lat. 11° N.	80°	July 14	16	15	20½	14	36½	14½
	81	July 15	16½	13	21	8	37½	10⅕

Thus nearly 37 oz. were excreted by the kidneys, leaving 51 oz. to be accounted for. Now the bile is scarcely if at all increased in the tropics, so that the liver gives little aid. Dalton* gives $\frac{1}{20}$ of the drink as the average thrown off in this form and by the bowels in temperate latitudes.

Taking this for the tropics also, allowing a little increase for bile, we have 4·4 oz. And reducing the water exhaled by the lungs in the temperate zone (which, according to Dalton, is $\frac{1}{4}$ of the drink or 22 oz.) by the same ratio as the respired air, viz. 11 per cent. or 2·42 oz., we have 19·58 oz. as that for the tropics. The sum of these two is 23·98 oz. Then the

51 oz. not thrown off by the kidneys
—23·98 oz. excreted by the lungs and bowels

gives 27·02 oz. for the skin to exhale.

So that the 88 oz. free fluid were got rid of thus :—

Urine 37 oz., skin 27·02 oz., lungs 19·58 oz., fæces 4·4 oz.

Had the water in the solid ingesta been reckoned, a difficult matter on shipboard, the experiment would have been more satisfactory. But this gives a fair approximation, inasmuch as any excess from this source would only have gone to increase the perspiration.

The relative excretion of free fluid by the skin, kidneys, lungs, and bowels, thus, differs in temperate and tropical latitudes, as they doubtless do in arctic regions (Table II.).

* Hooper, 'Physicians' Vade Mecum.'

TABLE II.—To show the relative excretion of free fluid in Temperate and Tropical latitudes.

Organ.	Temperate zone*.		Tropics.	
		oz. per cent.		oz. per cent.
Kidneys	(about)	$\frac{5}{8}$=45·25=59·54	(about)	$\frac{3}{7}$=37· =42·04
Lungs.....	(somewhat more than)	$\frac{1}{4}$=20·50=26·97	(somewhat more than)	$\frac{1}{5}$=19·58=22·25
Skin	(rather less than)	$\frac{1}{12}$= 6·50= 8·55		$\frac{3}{10}$=27·02=30·7
Bowels	(about)	$\frac{1}{20}$= 3·75= 4·93		$\frac{1}{20}$= 4·4 = 5·

While the urine thus decreases from 59½ to 42 per cent., the perspiration rises from 8½ to 30 per cent., there being a slighter fall of 4½ per cent. from the lungs, and a trifling rise from the bowels. The kidneys are thus the chief eliminators of surplus water in the tropics as in temperate regions; but in the former it is the skin, as in the latter it is the lungs that rank next. If suddenly stressed, however, by excessive imbibition, and the safety-valve action of the kidneys or skin be brought into play, these proportions doubtless differ. Will they hold good for permanent residents in the tropics, foreign or native?

The increased perspiration in the tropics or in artificial heat, and diminished urinary and pulmonic water-excretion by 22 per cent., is equal to a proportionate increase in the cutaneous circulation and corresponding withdrawal of blood from the kidneys to the extent of 17½ per cent., and lungs of 4½ per cent. Moreover this diminished exhalation of watery vapour from the lungs, by vicarious action of the skin, still further decreases the amount of blood circulating through them, already shown to be reduced by 12·24 per cent., or 16·62 fl. oz. by a diminished excretion of carbon†. The total decrease in the lung circulation is thus:—

16·62 fl. oz.
+ 6·42 „ (4·72 per cent.)

=23·04 fl. oz. as the total permanent withdrawal of blood from the lungs by an average temp. of 80–83° F.

These facts appear highly interesting in the etiology of these and other important internal and external organs, as well as hygienically and therapeutically suggestive.

The following results of the entire voyage from Bahia to England on a

* Hooper, 'Physicians' Vade Mecum.' In Dalton's experiment the amount of free fluid drunk was 76 oz., and in the above 88 oz. daily. The proportionate results, however, are the same in both.

† Proc. R. S. 1870, vol. xviii. p. 515.

daily allowance of 88 oz. free fluid (Table III.), will show that this *pari-passu* increase and decrease in the perspiration and urine are by no means uniform on going to or quitting the tropics, but oscillate considerably in all latitudes, both in quantity and contained solids, even in adjacent days.

TABLE III.—To show the quantity and contained solids of the Urine in a voyage across the tropics of 34 days.

Date.	Average temp. F.	Locality.	Urine.						
			Morning.		Evening.		Totals.		Contained solids.
			Quantity.	Sp. gr.	Quantity.	Sp. gr.	Quantity.	Sp. gr.	
1869.	°	Bahia.							grains.
Aug. 8.	76½	Lat. 13 S.							
„ 9.	77	„ 13·5 „	44	5	38	8	82	6·39	503·97
„ 10.	77½	„ 13·27 „	38	5	42	6	80	5·52	409·61
„ 11.	76½	„ 11·31 „	36	6	46	5	82	5·44	419·85
„ 12.	77	„ 8·46 „	19	10	46	5	65	6·46	399·78
„ 13.	78	„ 5·43 „	44	4	35	7	79	5·32	404·49
„ 14.	78	„ 3·9 „	42	4	32	8	74	5·72	378·89
„ 15.	77½	„ 0·38 „	36	5	42	4	78	4·49	319·17
„ 16.	78½		42	7	31	4	73	5·72	373·77
„ 17.	79	„ 1·37 N.	37	4	29	7	66	5·31	368·65
„ 18.	79½	„ 3·54 „	42	5	28	7	70	5·8	358·41
„ 19.	81	„ 5·40 „	20	9	39	6	59	7·01	423·79
„ 20.	81½	„ 7·17 „	20	9	29	8	49	8·40	494·61
„ 21.	80	„ 8·35 „	32	4	39	4	71	4·	290·53
„ 22.	81	„ 10·52 „	14½	10	38	4	52	5·71	266·25
„ 23.	81	„ 12·1 „	27	7	35	5	62	5·87	317·45
„ 24.	82½	„ 15·10 „	41	4	38	4	79	4·0	323·26
„ 25.	78½	„ 16·42 „	22½	7	21	9	43½	7·96	361·56
„ 26.	78½	„ 18·42 „	19	4	37	4	56	4·0	229·14
„ 27.	78	„ 21·13 „	27	4	23	9	50	6·3	301·52
„ 28.	78½	„ 23·52 „	24	8	35	3½	59	5·33	302·09
„ 29.	77	„ 26·15 „	26½	7	32½	4	59	5·34	302·09
„ 30.	78	„ 28·44 „	25	6	62	3	87	3·86	355·99
„ 31.	79	„ 28·59 „	19	6	53	4	72	4·52	294·62
Sept. 1.	79	„ 29·51 „	24	4	53	4	77	4·0	315·07
„ 2.	76	„ 30·18 „	12	11	37	4	49	5·75	250·89
„ 3.	76½	„ 32·6 „	18	8	44	4	62	5·16	317·45
„ 4.	74½	„ 33·27 „	13	7	53	4	66	4·59	270·06
„ 5.	73½	„ 34·58 „							
„ 6.	74	„ 36·20 „	20	8	51	4	71	5·12	362·47
„ 7.	73	„ 38·12 „	15	6	34	4	49	4·61	200·50
„ 8.	72	„ 38·58 „	17	5	35	5	50	5·0	255·26
„ 11.	66	„ 44·22 „	25	5	48	5	73	5·0	371·68
„ 12.	65	„ 46·5 „	14	8	56	5	70	5·6	357·36
„ 13.	65	„ 48·18 „	22	8	27	6	62	5·45	316·52

Thus on three consecutive days, taken at random, we find 49, 71, and 52 fl. oz., with 494, 290, and 266 grains of solids. The decrease in the latter, as well as in the fluid, is due partly to the reduced ingesta, and partly to the vicarious action of other organs, especially the skin and liver—and

doubtless involves not only the urea and chloride of sodium*, but all of its ordinary ingredients. Both would be far more regular if the system could be kept day by day in strictly similar conditions as to exercise, clothing, draughts, food, and especially drink—a difficult matter at sea, though possible on shore. So that by limiting the drink and increasing it only as thirst prompted, the quantity of urine would keep at a uniform and perhaps healthier standard. The individually different quantities necessary to accomplish this may be easily ascertained. Thus, allowing 25 oz. free fluid to be what my system requires daily in the average temperature of London (50° F.), the addition of 1 fl. oz. for every degree above, or its deduction for every degree below that, would keep the urine pretty equable, even though its specific gravity and solids might alter (Table IV.).

TABLE IV.—To indicate the daily quantity of drink necessary to keep the Urine nearly alike in Temperate and Tropical latitudes.

Temperature of air (F.)	30°	40°	50°	60°	70°	80°	90°
Free fluid required	5 oz.	15 oz.	25 oz.	35 oz.	45 oz.	55 oz.	65 oz.

This fact was proved by an experiment (of which Table V. is a synopsis) made in the Pacific in 1860–61, during a passage from Valparaiso (lat. 33° S.) to Vancouver (lat. 48° N.), when the drink was not kept uniform throughout as in Table III., but increased or decreased, as here indicated, with the desire.

TABLE V.—To contrast the Urine at the Equator and North and South Temperate Zones.

	Specific gravity of 7 cases.	Quantity in 1 case.
		oz.
Average of 7 days furthest south (lat. 33°), temp. 68° F....	1018$\frac{1}{7}$	36
,, ,, near equator (lat. 5°), ,, 78° F....	1018$\frac{3}{7}$	45·3
,, ,, furthest north (lat. 53°), ,, 58° F....	1017$\frac{1}{7}$	44·3

Here both the quantity and specific gravity increased somewhat; so that the urine is perhaps not so often or much diminished in the tropics as usually believed. It is so when the drink is stinted, and when, though ample, it is not increased and decreased with the temperature (Table III.); but when this is done it remains pretty uniform (Table V.), as it often does even when taken in excess. It is not so much the nephritic as the cutaneous secretion which alters with variations in the amount of drink in the tropics, and in temperate climates the reverse. The functionally excited skin acts as a

* Dr. Forbes Watson and Becker, as quoted in Parkes's 'Practical Hygiene.'

safety-valve for the kidneys in warm, as the latter do for the former in colder ones. While the perspiration depends much on the temperature, the urine is most influenced by the drink. Although heat, or its absence (cold), is thus the chief agent in causing these fluctuations, the humidity, velocity, &c. of the air are not altogether negative. The first acts by stimulating or checking the sudatory glands, and all three by favouring or opposing evaporation. Frequent change of climate tends to develope the ordinary and safety-valve range of action in both organs. In these facts lie several important hygienic and therapeutic indications for the tropics, with a view to prevent or lessen distressing hyperæmia of the skin and excessive perspiration, both the result of undue imbibition, and the latter highly dangerous when suddenly checked, and a frequent cause of disease. By them the reason of the efficacy of tropical, and especially subtropical climates in the prevention when imminent, and cure or relief when actually present, of many diseases of internal organs, not of the abdomen alone, but of thoracic ones, is explained. The sanatory hæmatic and secretive derivative action of natural (tropical) and artificial heat has been already pointed out with regard to the lungs*. Might not the practical physician more frequently act on this hint as to the means and extent by which both the circulation and the function of diseased or over-taxed internal organs may be relieved by thus transferring their blood-current and secretion to sounder ones? Is not this great and general law of a derivation of blood from internal to external organs under heat, and the reverse under cold, the soundest and most philosophical basis on which to erect a new, safe, satisfactory, and permanent system of therapeutics and hygienics?

V. *The Influence of Tropical Climates on the Weight and Strength.*

Besides the already discussed functional, vascular, and other changes in the lungs, skin, kidneys, and other organs of *vegetable* life, which follow a transition from temperate to tropical climates, various phenomena affecting those of *animal* life are also common—*e. g.* languor of body and brain, and generally a loss of weight. More tardy and less evident, but equally worth study, these are not due, like the former, to the general diversion in the blood-current from internal to external parts, but to changes in the blood itself and the tissues which it nourishes, to be hereafter investigated.

Occasionally an individual fattens on going to the tropics, and, instead of losing, gains health and strength. Again, a corpulent person may decrease considerably in weight, while his health, so far from impairing, actually improves. But such cases are exceptional, and, doubtless, consist merely in vitally unimportant fluctuations in the adipose tissue; and as a rule the issue includes a loss in both respects, which, if not disease, is closely allied to it. An opposite result usually follows a contrary change of climate.

* Proc. R. S. 1870, vol. xviii. p. 520.

The following experiments to illustrate this were made in H.M.S. 'Salamander,' during a voyage of five months to, and a subsequent stay of three years on the east coast of Australia, while making triannual trips between Sydney (lat. 34°) and Cape York, Torres Strait (lat. 10½° S.), a distance of 1700 miles in a nearly north and south direction. The crew numbered 209, their ages being :—

between 15 and 25 (period of growth) ..... 129 (61·72 per cent.).
„ 25 „ 35 (adult age) ..... 63 (30·14 „).
„ 35 „ 45 (1st period of decline).... 16 (7·66 „).
„ 45 „ 55 (2nd „ „).... 1 (0·48 „).

Thus 192 (91·86 per cent.) were under thirty-five, which may be considered the prime of life among seamen; while the whole were healthy. They were weighed as far as possible in the same clothes, and between 6 and 7 P.M., about two hours after a light "supper" of tea and biscuit, in order to reduce error from variations in the state of the bowels, stomach, bladder, &c., to a minimum. Their faulty diet, however, unmodified for temperature, and containing salt meat and other hurtful articles, was an unavoidable disadvantage. Fortunately this enables us to observe the effect of an agency far more under control for modification or removal than climate.

TABLE I.—To show the effect of Tropical Weather alone on the weight.

1st weighing, July 2, 1866, on entering tropics,
2nd „ October 18, 1866, on quitting tropics, } 108 days, all spent in the tropics.

Average temperature at Sydney 60° F., at Cape York 82° F.

Salt meat issued on ..... 36 days
(with 61 lime-juice days)
Fresh meat issued on..... 72 „

Food consumed per man daily.

	lb.	oz.	drs.
Average of first week ...	2	5	12¼
„ last „ ...	2	2	9¾

Age.	Total number weighed.	Number and percentage unchanged.	Number and percentage who gained.	Range of gain.	Average gain.	Number and percentage who lost.	Range of loss.	Average loss.
		per cent.	per cent.	lb.	lb.	per cent.	lb.	lb.
15 to 25	35	3= 8·57	13=37·14	1–8	3	19=54·28	1–14	5·16
25 „ 35	39	3= 7·7	8=20·51	2–10	3·37	28=71·8	1–12	4·7
35 „ 45	9	.....	2=22·22	1–2	1·5	7=77·77	1–17	5·71
45 „ 55	2	1=50	.....	.....	.....	1=50	.....	5
Totals and percentages.	85	7= 8·24	23=27·06	1–10	3	55=64·71	1–17	5
		30=35·3 per cent.						

Table I. shows the effect of 3½ months' exposure to an average temperature of 82° F. towards Torres Strait. Of 85 weighed, 64½ per cent. had lost flesh to an average of 5 lbs. Though greatest among the adults (71 per cent.), and especially the higher ages (77½ per cent.), it was large even among the juniors, of whom 54 per cent. instead of growing, lost con-

siderably. Lime-juice was given; but the 36 days of salt meat doubtless added to these results; and to make the experiment thoroughly satisfactory, fresh meat should alone be issued—almost an impossibility in the present transition state of naval dieting. Still the event is sufficiently decisive to prove the prejudicial influence of tropical climates on the physique, at all ages. Of 15 officers and men subsequently tested after 17 days more prolonged and direct solar exposure, but with a larger allowance of fresh (preserved) meat, 11 had lost from 1 to 9 lbs. (average $3\frac{3}{11}$), 1 being unchanged, while 3 had gained. Of the latter, one was a black (and therefore in his native climate), who increased 1 lb., the other two being healthy boys who gained 1 and 2 lb. respectively. This shows that the wasting effect of tropical weather in the adult white is not preventible even by a judicious regimen.

TABLE II.—To show the effect of Tropical Climate and Salt-meat Diet on the weight.

1st weighing, October 9, 1865, at Cape York,
2nd „ November 6, 1865, at Cape York, } 28 days, all spent in the tropics.

Average temperature at Sydney 69° F., at Cape York 84° F.

Salt meat issued on ..... 24 days
(with 28 lime-juice days)
Fresh meat issued on..... 4 „

Food consumed per man daily.

	lb.	oz.	drs.
Average of first week ...	2	1	7
„ last „ ...	2	2	9

Age.	Total number weighed.	Number and percentage unchanged.	Number and percentage who gained.	Range of gain.	Average gain.	Number and percentage who lost.	Range of loss.	Average loss.
		per cent.	per cent.	lb.	lb.	per cent.	lb.	lb.
15 to 25	33	3=9·09	6=18·18	1–10	4	24=72·73	1–10	4
25 „ 35	33	2=6·06	2= 6·06	1–4	$2\frac{1}{2}$	29=87·87	1–10	6
35 „ 45	7	.....	1=14·3	.....	6	6=85·71	2–12	5
45 „ 55	3	.....	.....	.....	.....	3=100	3–10	5·66
Totals and percentages.	76	5=6·58	9=11·84	1–10	3·88	62=81·58	1–12	4·18
		14=18·42 per cent.						

Table II., the results of another northward cruise, shows how much this loss of weight is increased when the diet is one of salt meat*. The season being the same (S.E. monsoon), though the exposure was shorter by 80 days, no fewer than 81 per cent. lost to an average of 4 lbs.—this, among the boys and youths, being larger than before, even though their food was increased; which proves that a diet like this, not only highly salted but too nitrogenous for warm climates, adds materially to the injurious influence of tropical weather at all ages. After a more prolonged stay at Cape York (one year), eleven marines, fed on a mixed, fresh and salt-meat diet, had lost weight to the average extent of $11\frac{9}{11}$ lbs.

* *i. e.* The ordinary sea dietary, in which 1 lb. of salt meat, beef and pork alternately, forms the chief part of the dinner.

TABLE III.—To show the conjoint effect of Tropical Climate, Salt Meat, and hard Subsolar work on the weight.

1st weighing, June 2, 1864, on entering tropics,
2nd „ September 14, 1864, on quitting tropics, } 104 days { 62 in the tropics, 42 in temp. zone.

Average temperature at Cape York 80° F.

Salt meat issued on ..... 51 days
(with 90 lime-juice days)
Fresh meat issued on..... 53 „

Food consumed per man daily.

	lb.	oz.	drs.
Average of first week ...	2	5	$11\frac{2}{3}$
„ last „ ...	2	8	$3\frac{4}{7}$

Age.	Total number weighed.	Number and percentage unchanged.	Number and percentage who gained.	Range of gain.	Average gain.	Number and percentage who lost.	Range of loss.	Average loss.
		per cent.	per cent.	lb.	lb.	per cent.	lb.	lb.
15 to 25	63	2=3·18	3=4·76	2–2	2	58=92·06	1–24	6·34
25 „ 35	35	1=2·86	3=8·57	4–8	5·33	31=88·57	1–17	7·74
35 „ 45	5	.....	.....	.....	.....	5=100	5–16	9·2
45 „ 55	.....	.....	.....	.....	.....	.....	.....	.....
Totals and percentages.	103	3=2·91	6=5·82	2–8	3·66	94=91·26	1–24	6·96
		9=8·74 per cent.						

Table III., the record of another trip to Torres Strait, also during the S.E. monsoon, shows that the body is still further affected when a third injurious influence, viz. hard subsolar work, is added to these. Thus, of 103 weighed, 1 per cent. lost flesh to an average of 7 lb. nearly; the number of boys and young men being large, because most employed, although the average individual loss was greatest among the seniors—thus 6 lb., 7 lb., and 9 lb. under 25, 35, and 45 respectively. This did not arise from a reduced diet; for the daily average consumption at the end of the period, when thus losing, had increased by $3\frac{1}{4}$ oz. per man.

A contrast of Tables IV. and V. further shows that *season* materially influences this reduction in weight. Table IV. gives the results of 46 days during the cool dry S.E. monsoon (aver. temp. 82° F.), which lasts for 9 months; and Table V. of 54 days during the sultry rainy N.W. monsoon (aver. temp. 87° F.), an exaggerated form of tropical weather related to the other as are the winter and summer in temperate latitudes. While the number who lost flesh during the dry season was 44 per cent., it was 76 per cent. during the wet monsoon. The small per centage of gain even among the strong and vigorous juniors in the wet season, viz. 10 and $14\frac{1}{2}$ per cent., is worthy of contrast with that of the dry season, viz. $59\frac{1}{2}$ and $43\frac{1}{2}$ per cent., as it shows that even the healthiest age cannot long withstand the emaciating influence of the worst season of the tropical year. The high average percentage of loss (7 lb.) and low percentage of gain, $2\frac{4}{5}$ lb., during the wet, contrasted with that of the dry monsoon (3 lb. and $4\frac{7}{10}$ lb.), which equally affects all ages, further illustrates this. The in-

creased ingesta towards the end of both experiments could not prevent these results; nor is the difference between the two seasons ascribable to a material dissimilarity in the quantity of the food.

TABLE IV.—To show the effect of *Season* in the Tropics on weight.

Cool and Dry. S.E. Monsoon.

Average temperature at Cape York 82° F.

1st weighing, April 11, 1865, on entering tropics,
2nd „ June 23, 1865, on quitting tropics, } 73 days { 46 in the tropics, 27 in temperate zone.

Salt meat issued on ..... 62 days.
(with 55 lime-juice days)
Fresh meat issued on..... 11 „

Food consumed per man daily.

	lb.	oz.	drs.
Average of first week ...	1	11	$3\frac{2}{5}$
„ last „ ...	1	15	$4\frac{11}{15}$

Age.	Total number weighed.	Number and percentage unchanged.	Number and percentage who gained.	Range of gain.	Average gain.	Number and percentage who lost.	Range of loss.	Average loss.
		per cent.	per cent.	lb.	lb.	per cent.	lb.	lb.
15 to 25	37	2=5·41	22=59·5	1–12	4·36	13=35·14	1–9	2·61
25 „ 35	32	1=3·13	14=43·75	2–14	5·36	17=53·12	1–12	3·94
35 „ 45	9	1=1·11	3= 3·33	3–7	5	5= 5·55	1–9	3·8
45 „ 55	1	1=100	.....	.....	.....	.....	.....	.....
Totals and percentages.	79	5=6·32	39=49·37	1–14	4·77	35=44·30	1–12	3·15
		44=55·69 per cent.						

TABLE V.—To show the effect of *Season* in the Tropics on weight.

Wet and Sultry. N.W. Monsoon.

Average temperature at Cape York 87° F.

1st weighing, November 25, 1864, on entering tropics,
2nd „ February 9, 1865, on quitting tropics, } 76 days { 54 in the tropics, 22 in temp. zone.

Salt meat issued on ..... 70 days
(with 60 lime-juice days)
Fresh meat issued on..... 6 „

Food consumed per man daily.

	lb.	oz.	drs.
Average of first week ...	1	10	1
„ last „ ...	1	14	2

Age.	Total number weighed.	Number and percentage unchanged.	Number and percentage who gained.	Range of gain.	Average gain.	Number and percentage who lost.	Range of loss.	Average loss.
		per cent.	per cent.	lb.	lb.	per cent.	lb.	lb.
15 to 25	49	8=16·33	5=10·2	1–5	2·2	36=73·47	1–16	6
25 „ 35	34	2= 5·88	5=14·71	1–8	3·4	27=79·41	1–16	8
35 „ 45	9	1= 1·11	.....	.....	.....	8=88·88	4–20	9·62
45 „ 55	1	1=100	.....	.....	.....	.....	.....	.....
Totals and percentages	93	12=12·91	10=10·75	1–8	1·8	71=76·34	1–20	7·15
		22=23·65 per cent.						

TABLE VI.—To show the influence of Temperate Climates &c. on the weight.

1st weighing, September 14, 1864, near Sydney,
2nd „ November 25, 1864, after leaving Sydney, } 72 days, all spent in the temp. zone.

Average temperature at Sydney 65° F.

Salt meat issued on ..... 35 days
(with 20 lime-juice days)
Fresh meat issued on..... 37 „

Food consumed per man daily.

	lb.	oz.	drs.
Average of first week ...	2	8	3⅘
„ last „ ...	1	10	1

Age.	Total number weighed.	Number and percentage unchanged.	Number and percentage who gained.	Range of gain.	Average gain.	Number and percentage who lost.	Range of loss.	Average loss.
		per cent.	per cent.	lb.	lb.	per cent.	lb.	lb.
15 to 25	43	3= 6·98	35=81·39	2–11	5·91	5=11·63	1–6	3
25 „ 35	32	4=12·5	26=81·25	2–14	6·5	2= 6·25	2–3	2·5
35 „ 45	8	.....	7=87·5	1–15	7·14	1=12·5	1	1
45 „ 55	.....	.....	.....	.....	.....	.....	.....	.....
Totals and percentages.	83	7= 8·43	68=81·93	1–15	6·3	8= 9·64	1–6	2·62
		75=90·36 per cent.						

Table VI., in strong contrast to the above, shows how much and rapidly the system rebounds under an opposite change of climate, and when removed from excessive warmth into a healthy temperate climate, with a fresh meat and vegetable diet, light work, frequent leave, &c. Thus after a 54 days' stay at Sydney in spring, notwithstanding the debilitating effect of 35 salt meat days before and after the experiment, no fewer than 90 per cent. had either gained flesh or lost nothing, the average gain being large (6 lbs.). In the 9½ per cent. who lost, this was probably due, as it occurred among the juniors, to those excesses so common after long confinement on board.

Thus, during the three years over which these triannual trips from Sydney to Cape York extended, the weight of the crew was continually oscillating, increasing at the former, and again decreasing on returning to the tropics. Frequent, sudden, and great changes of temperature and climate like this, are doubtless fertile causes in undermining the constitution and inducing premature old age. But for the re-invigorating influence of the periodic return to cool weather, many more would have succumbed to broken health. As it is, Table VII. shows that after 1½ years 44 per cent. of those who originally went out in the ship had lost flesh, while other evidence showed that the health and strength of all had declined, there being moreover no proof of the occurrence in any of that doubtful event, acclimatization. The appetite and consumption of food had also diminished from the same cause.

TABLE VII.—To show the effect of a $1\frac{1}{2}$ year's stay in a Tropico-temperate region on the weight (including 4 trips between Sydney and Cape York).

1st weighing, August 10, 1864, near Cape York,
2nd „ November 6, 1865, near Cape York, } 453 days { 184 in the tropics, 269 in temp. zone.

Salt meat issued on ..... 229 days (with 154 lime-juice days)
Fresh meat issued on ... 224 „

Food consumed per man daily.

	lb.	oz.	drs.
Average of first week ...	2	8	7
„ last „ ...	2	1	7

Age.	Total number weighed.	Number and percentage unchanged.	Number and percentage who gained.	Range of gain.	Average gain.	Number and percentage who lost.	Range of loss.	Average loss.
		per cent.	per cent.	lb.	lb.	per cent.	lb.	lb.
15 to 25	29	1=3·45	18=62·07	2–15	6·17	10=34·48	2–14	6
25 „ 35	27	4=14·81	8=29·63	1–16	5·125	15=55·55	1–15	5·6
35 „ 45	5	.....	3=60	5–10	8	2=40	1–3	2
45 „ 55	.....	.....	.....	.....	.....	.....	.....	.....
Totals and percentages.	61	5=8·19	29=47·54	1–16	6·08	27=44·26	1–15	5·52
		34=55·74 per cent.						

During the next eighteen months the crew had more fresh meat in the northward trips, the beneficial influence of which manifested itself by reducing the percentage of those who lost flesh to $28\frac{1}{2}$ (Table VIII.), as well as the percentage of loss. The appetite, however, remained much impaired.

TABLE VIII.—To show the effect of a 3 years' stay in a Tropico-temperate region on the weight (including 8 trips between Sydney and Cape York).

1st weighing, August 10, 1864, near Cape York,
2nd „ September 25, 1867, near Cape York, } 1141 days { 532 in the tropics, 609 in temp. zone.

Salt meat issued on ..... 575 days (with 540 lime-juice days)
Fresh meat issued on ... 566 „

Food consumed per man daily.

	lb.	oz.	drs.
Average of first week ...	2	8	7
„ last „ ...	1	11	10

Age.	Total number weighed.	Number and percentage unchanged.	Number and percentage who gained.	Range of gain.	Average gain.	Number and percentage who lost.	Range of loss.	Average loss.
		per cent.	per cent.	lb.	lb.	per cent.	lb.	lb.
15 to 25	25	1=4	19=67	3–40	14·68	5=20	3–12	5·2
25 „ 35	15	1=6·66	8=53·33	1–18	7·125	6=40	1–15	6·16
35 „ 45	2	1=50	.....	.....	.....	1=50	0–1	1
45 „ 55	.....	.....	.....	.....	.....	.....	.....	.....
Totals and percentages.	42	3=7·14	27=64·29	1–40	12·5	12=28·57	1–15	5·42
		30=71·43 per cent.						

A similar slowly progressive impairment of the physique also occurs during long sea voyages, in which ships pass repeatedly and suddenly from cold or temperate to tropical latitudes, and the reverse.

TABLE IX.—To show the effect of a long voyage of 55 days (including Tropical Weather and Salt Meat) on the weight.

Average temperature, England 50° F., Equator 88° F., South Atlantic 72° F.

1st weighing, January 9, 1864, England,
2nd „ March 4, 1864, South Atlantic, } 55 days { 34 in the tropics, 21 in temp. zone.

Salt meat issued on ..... 50 days (with 11 lime-juice days)
Fresh meat issued on..... 5 „

Food consumed per man daily.

	lb.	oz.	drs.
Average of first week ...	1	12	13⅓
„ last „ ...	2	3	1⅓

Age.	Total number weighed.	Number and percentage unchanged.	Number and percentage who gained.	Range of gain.	Average gain.	Number and percentage who lost.	Range of loss.	Average loss.
		per cent.	per cent.	lb.	lb.	per cent.	lb.	lb.
15 to 25	80	4=5	25=31·25	1–11	3·84	51=63·75	1–23	6·72
25 „ 35	45	3=6·66	13=28·88	1–13	3·77	29=64·44	1–20	7·41
35 „ 45	13	.....	3=23·07	4–7	5	10=76·91	1–19	6·3
45 „ 55	.....	.....	.....	.....	.....	.....	.....	.....
Totals and percentages.	138	7=5·07	41=29·71	1–13	3·9	90=65·22	1–23	6·93
		48=34·78 per cent.						

Thus Table IX. shows that after a 55 days' passage from the cool climate of England across the equator to the south temperate zone, 65 per cent. of the crew had lost flesh to an average of 7 lb. nearly—the juniors suffering, though not so much as the seniors. An increased sick-list at the close corresponds to this. These results were not due to a decrease in the ingesta, as the daily consumption during the last averaged 6 oz. more than during the first week. The cause was therefore partly climatic and partly dietetic, salt meat being issued most of the time.

TABLE X.—To show the effect of a long voyage in the Temperate Zone, but on Salt Meat, on the weight.

Average temperature, Cape of Good Hope 65° F., Sydney 62° F.

1st weighing, April 19, 1864, Cape of Good Hope,
2nd „ June 2, 1864, near Sydney, } 49 days, all spent in the temp. zone.

Salt meat issued on ..... 48 days (with 39 lime-juice days)
Fresh meat issued on..... 1 day

Food consumed per man daily.

	lb.	oz.	drs.
Average of first week ...	2	5	4⅘
„ last „ ...	2	5	11⅔

Age.	Total number weighed.	Number and percentage unchanged.	Number and percentage who gained.	Range of gain.	Average gain.	Number and percentage who lost.	Range of loss.	Average loss.
		per cent.	per cent.	lb.	lb.	per cent.	lb.	lb.
15 to 25	77	8=10·39	60=77·92	1–11	4·78	9=11·61	1–4	2·11
25 „ 35	41	4= 9·75	22=53·66	1–19	5·54	15=36·60	1–9	3·66
35 „ 45	14	3=21·43	9=64·30	2–8	5	2=14·30	1–2	1·5
45 „ 55	.....	.....	.....	.....	.....	.....	.....	.....
Totals and percentages.	132	15=11·36	91=69·69	1–19	5	26=19·69	1–9	2·58
		106=80·30 per cent.						

Very different was the effect of the 44 days' continuation of the voyage to Sydney along the 40th parallel of south latitude, after a health-infusing stay of fifteen days at Simons Bay (Table X.). Although the usual sea dietary was continued, the exit from the tropics was an evident relief to the system, which, but for the diet, would have retained its vigour throughout. As it was, only 26, =19·69 per cent., lost flesh slightly. All the boys, who had the strong vital resilience of youth in their favour, gained in weight, and also the younger men, while the seniors lost. An increase in the ingesta of 7 drams daily towards the end of the period is too trivial to have influenced these results. This shows how long the system will ward off the scorbutic diathesis when opposed by no other serious adverse agency, provided lime-juice is given as a prophylactic. The increased sick-list and intensity of the ailments, however, towards the end of the period, show that the immunity was passing off. The difference in the percentage of those who lost flesh in this and the former part of the voyage (Table IX.), is evidently the effect of climate, and indirectly confirms Tables I. and II.

To the bracing effect of the S. temperate zone we must chiefly ascribe the recovery of the crew. Wasted while crossing the equator, only 29 per cent. were below their original weight in England on arrival at Sydney. This loss, though evident among the juniors, was chiefly among the adults and older men (Table XI.). The superior health and efficiency of a crew in cool climates is an evident indication in planning long voyages. And we have only to recollect the position and direction of the chief winds and ocean-currents usually followed, to see how much these favour the maintenance of health as well as rapidity of progress.

TABLE XI.—To show the effect of a voyage of 144 days on the weight.

Average temperature in England 50° F., Equator 88° F., Sydney 62° F.

1st weighing, January 9, 1864, in England,
2nd „ June 2, 1864, near Sydney,
} 144 days { 27 in the tropics, 117 in temp. zone.

Salt meat issued on ..... 110 days
(with 50 lime-juice days)
Fresh meat issued on ... 34 „

Food consumed per man daily.

	lb.	oz.	drs.
Average of first week ...	1	12	13⅓
„ last „ ...	2	5	11⅔

Age.	Total number weighed.	Number and percentage unchanged.	Number and percentage who gained.	Range of gain.	Average gain.	Number and percentage who lost.	Range of loss.	Average loss.
		per cent.	per cent.	lb.	lb.	per cent.	lb.	lb.
15 to 25	76	5=6·58	52=68·42	1–18	5·73	19=25	1–25	5·47
25 „ 35	42	3=7·14	25=59·52	1–15	5·76	14=33·33	1–15	5·85
35 „ 45	12	1=8·33	6=50	3–7	5	5=41·66	1–14	7·2
45 „ 55	.....	.....	.....	.....	.....	.....	.....	.....
Totals and percentages.	130	9=6·92	83=63·85	1–18	5·69	38=29·23	1–25	5·84
		92=70·77 per cent.						

The passage to Cape York, however, again increased the general symptoms of an impaired physique (Table XII.), thus proving the existence of a constant ebb and flow in the state of health during long voyages.

TABLE XII.—To show the effect of a voyage of 230 days on the weight.

Average temperature, England 50° F., Equator 88° F., Sydney 62° F., Cape York 80° F.

1st weighing, January 9, 1864, England, } 230 days { 50 in the tropics,
2nd „ August 10, 1864, Cape York, } { 180 in temp. zone.

Salt meat issued on ..... 156 days (with 73 lime-juice days)
Fresh meat issued on ... 74 „

Food consumed per man daily.

	lb.	oz.	drs.
Average of first week ...	1	12	13½
„ last „ ...	2	8	7

Age.	Total number weighed.	Number and percentage unchanged.	Number and percentage who gained.	Range of gain.	Average gain.	Number and percentage who lost.	Range of loss.	Average loss.
		per cent.	per cent.	lb.	lb.	per cent.	lb.	lb.
15 to 25	61	7=11·48	18=29·51	1–19	7·11	36=59·01	1–32	6·1
25 „ 35	35	1=2·86	8=22·86	1–16	4·87	26=74·28	1–22	6·54
35 „ 45	7	.....	2=14·29	1–2	1·5	5=71·43	6–23	13·8
45 „ 55	.....	.....	.....	.....	.....	.....	.....	.....
Totals and percentages.	103	8=7·77	28=27·18	1–19	5·36	67=65·05	1–32	6·83
		36=35 per cent.						

Thus, though 55 days in all were spent at Madeira, Simons Bay, Sydney, and Brisbane, on a health-giving fresh meat and vegetable diet (see Table VI), and lime-juice freely given, the monotony and confinement of 175 days at sea, with 156 salt-meat days, a double exposure to the tropics, and frequent changes of temperature, had increased the number who had lost weight since leaving England to 65 per cent.—a decided index of failing health and near approach to disease, and perhaps the scorbutic climax.

Similar fluctuations in weight, subsequently observed in the larger crew of H.M.S. 'Bristol' during a voyage of 88 days from England to Bahia (lat. 11° S.) and back, are equally interesting and instructive (Table XIII).

Thus the warm weather and salt-meat diet of the first 57 days caused 85 per cent. to lose weight, which rose to 88 per cent. as the time lengthened to 88 days. The return to the north temperate zone, however, speedily reduced this to 47 per cent. As the diet was the same, the latter event must have been purely climatic—an opinion confirmed by the subsequent effect of 28 days' harbour-life in England, when the number who lost went down to 10·7 per cent., no fewer than 89 per cent. regaining flesh and more than making up for the previous loss.

TABLE XIII.—To show the effect of climate and diet on the weight of an adult crew, June 18 to September 14, 1869.

Average temperature, England 60° F., Equator 77° F., Bahia 76° F.; England (return) 60° F.

Remarks.	Total number weighed.	Number and percentage who gained or did not lose.	Range of gain.	Average gain.	Number and percentage who lost.	Range of loss.	Average loss.
		per cent.	lb.	lb.	per cent.	lb.	lb.
Effect of first 57 days	425	64=15·06	1–15	2·58	361=84·94	1–28	5·75
of which { 45 in the tropics							
{ 38 on salt meat.							
Effect of first 88 days	296	36=12·18	½–13	3·5	260=87·84	1–30	5·47
of which { 66 in the tropics							
{ 61 on salt meat.							
Effect of last 31 days	310	164=52·93	½–9	2·64	146=47·1	½–10	2·81
of which { 21 in the tropics							
{ 10 on salt meat.							
Subsequent effect of 28 days in harbour (England) on fresh meat and vegetables.	391	349=89·26	1–19	4·70	42=10·74	1–9	2·66

Table XIV. shows that, while the same prevailed among the ship's boys (age 17 to 20) and naval cadets (age 14 to 17), youth and lighter work &c., have an evident effect in lessening the percentage of loss under such adverse agencies, and increasing the gain under opposite conditions.

TABLE XIV.—To contrast the variations in weight, during long voyages, of the men, boys, and naval cadets, June 18 to September 14, 1869.

Average temperature, England 60° F., Equator 77° F., England (return) 60° F.

England to Bahia (lat. 11° S.), 88 days.	Total number weighed.	Number and percentage who gained or did not lose.	Number and percentage who lost.
		per cent.	per cent.
Effect of first 57 days	Men 425	64= 15·06	361=84·94
of which { 45 in the tropics,	Boys 64	28= 43·74	36=56·25
{ 38 on salt meat.	Cadets 60	23= 38·33	37=58·33
Effect of first 88 days	Men 296	36= 12·18	260=87·84
of which { 66 in the tropics,	Boys 40	16= 35	24=60
{ 61 on salt meat.	Cadets 58	20= 34·47	38=65·51
Effect of last 31 days	Men 310	164= 52·93	146=47·1
of which { 21 in the tropics,	Boys 41	30= 73·17	11=26·82
{ 10 on salt meat.	Cadets 59	34= 57·62	25=42·37
Subsequent effect of 28 days in harbour (England) on fresh meat and vegetables.	Men 391	349= 89·26	42=10·74
	Boys 34	30= 90·58	4=11·76
	Cadets 28	28=100	

Thus 85 per cent. of the men lost flesh during the first 57 days, but only 56 per cent. of the boys, and 58 per cent. of the cadets. Again, during the first 88 days the percentages were—men 88, boys 60, cadets 65. Further, while 53 per cent. of the men began to recover weight on reentering cool weather, 73 per cent. of the boys and 58 per cent. of the cadets did the same. Lastly, in England, while 89 per cent. of the men gained, among the boys we find 90½ per cent., and among the cadets 100 per cent. The advanced age, greater strength, and rougher early life of the boys enabled them to bear the voyage better, and recover sooner under genial agencies than the younger delicately-reared cadets. On the other hand, a generous diet and better regulated life caused the latter to increase more in England. Under favourable conditions, as to climate, diet, &c., the weight of men, and particularly boys, should not fluctuate thus. Nor can such changes be salutary. As a rule adults, with fully developed frames, should remain pretty stationary in weight. Boys, however, should increase not only in weight, but in height and breadth of chest. For the former to emaciate, or the latter to grow taller and broader, while the weight remains the same or lessens, is a sure sign of present or impending mischief. The average of 1½ lb. per week by which these cadets increased at home, may be considered the healthy rate of growth for boys of their age. And we may give Table XV. to show the effect of subsequent longer leave in England on the physique of a larger number of cadets.

TABLE XV.—To show the effect of a healthy diet and climate on the physique of naval cadets, age from 14 to 17 (September and October 1870; time 44 days; temperature 64° F.).

	Total number.	Number and percentage unchanged.	Number and percentage of gain.	Range of gain.	Average gain.	Number and percentage of loss.	Range of loss.	Average loss.
		per cent.	per cent.	lb.	lb.	per cent.	lb.	lb.
Weight.	52	1= 1·925	48=92·31	1–20	5·93	3=5·77	1–2	1·66
				in.	in.	.....		
Height..	54	20=37·04	34=63	¼–2¼	0·67		.....	.....
Chest ...	not m	easured.	.....	.....	.....	.....	.....	.....

Thus, of 52 cadets, 93 per cent. either did not lose or gained flesh to the average of 1 lb. per week, while 63 per cent. increased in height, and no doubt in capacity of chest; but the time was too short to obtain satisfactory results as to this. Obviously, therefore, if cadets are long subjected to influences which retard their growth, even if disease does not ensue, their future strength, both of body and brain, is apt to be impaired; while ship's boys and young seamen are not likely to become physical athletes, nor adults to retain their vigour as fighting men. These conclusions necessarily apply to all similarly situated.

If we can isolate the effects of tropical weather so as to contrast them with those of other health-impairing agencies, it will be both interesting and practically useful. Table XVI. shows when we find the greatest gain or greatest loss of weight. Life under the healthiest conditions, in which the highest gain (90½ per cent.) and lowest loss (9½ per cent.) occurs, is first given as a standard for comparison and index of what should be aimed at in all latitudes and circumstances.

TABLE XVI.—To compare the effect of climate and other agencies on the weight.

Reference.	Pernicious influences.	Gain or unchanged		Loss	
		Per cent.	Average.	Per cent.	Average.
			lb.		lb.
Table VI.	None	90·36	6·3	9·64	2·62
„ X.	One (salt meat)	81·05	5	19·69	2·58
„ I.	One (tropical climate)	35·30	3	64·71	5
„ IX.	Two (tropical climate, dry season, and salt meat).	34·78	3·9	65·22	6·39
„ V.	Two (tropical climate, wet season, and salt meat).	23·66	2·8	76·34	7·15
„ III.	Three (tropical climate, salt meat, and hard work).	8·73	3·66	91·26	6·96

We here notice a progressive decrease in the number who gain or do not lose in weight, and necessarily a corresponding increase in the percentage of those who lose, according to the variety and intensity of the adverse agencies. Thus fewest emaciate when the influences are altogether genial, viz. 9·64 per cent. An injurious diet raises this to 19·69 per cent. Under tropical climate it rises to 64·71. Under the latter and salt meat combined, it again rises to 65·22 per cent., and in the rainy season to 76·34 per cent. When, besides this, hard work is undergone, it mounts to 91·26 per cent. The average gain and loss columns show a similar though less regular increase and decrease. Tropical climate is thus by far the most injurious influence; and its effects are materially aggravated by other adverse agencies. [And the Tables show that these facts apply to the junior as well as the senior ages, though occasionally more apparent in the latter.—Feb. 27.]

We must know the nature of these universal and marked changes in the weight, and the tissues involved, before we can decide whether they are physiological or pathological, and, if the latter, satisfactorily direct our hygienic or therapeutic efforts to prevent or remedy them. We cannot ascertain by anatomical or histological investigation; but we may fairly suppose that every or nearly every tissue is more or less implicated—those

which carry on the functions of animal life being most affected, especially such as form the great bulk of the body. It would be difficult to say whether the watery part of the blood and body generally is reduced by excessive perspiration. The osseous system and thoracic and abdominal viscera are probably little changed. The fibrous and gelatinous are perhaps more altered; but it would be difficult to separate this from the change in the fatty muscular and nervous tissues, the three doubtless most of all affected. In warm latitudes less fat is required than in cold ones to keep out cold and generate internal heat or muscular force. Hence nature uses it up in its vital processes, and thus first gets rid of what does not itself play a vital part in the human economy, or materially influence health by its removal, and would only prove an encumbrance. The prevalent languor of body and mind no doubt arise partly from diminished energy in the nervous and muscular tissues; but are they not also, and perhaps principally, due to a decrease in their bulk, similar to that in other tissues? Strength is the manifestation of muscle acted on by nervous influence; and, from several experiments made on the officers and crew of H.M.S. 'Bristol,' strength decreases and increases with the foregoing changes in weight—a fact which goes far to prove that though loss of strength may be partly of nervous origin, the muscular tissue is also largely involved in its production, and is probably both physiologically weakened and physically altered in texture*.

The cause of this reduction in weight in the tropics is threefold:—first, a diminished necessity for surplus fat, which becomes absorbed; second, that peculiar and not easily explained physiological effect of heat, which causes the tissues to decay faster than in cold latitudes; third, diminished lung-work and blood-oxygenation, and thereby an imperfect renewal of tissue. On the other hand, the languor and weakness are due, first, to loss and relaxation of the muscular substance; second, to a similar loss of nervous tone and matter; third, to suboxidation of the blood†, which impairs the activity not only of the muscles, but of the nerve-centres which originate, and nerve-cords which transmit motor and sensory impressions; [and, fourthly, in their early stage, to a reduced supply of their vital stimulant the blood, diverted from the internally situated nerve centres, nerves, and muscles, to the cutaneous surface.—Feb. 27.] The early and primary results of tropical warmth on the tissues are probably chiefly physical and quantitative; but when prolonged, especially if conjoined with an erroneous diet, their composition is affected, and they are also chemical and qualitative.

What are the true bearings and diagnostic value of this closely-allied loss of weight and strength? Are they solely physiological? or when do they become pathological? Do they always, or at what stage do they indicate

* These data were scarcely ample enough for tabulation. The ship's motion, imperfect testing apparatus, and difficulty of finding one equally suited for all men, in whom the best-developed sets of muscles often differ, make this a troublesome inquiry.

† Proceedings of the Royal Society for 1870, No. 122, p. 520.

a loss of vitality or health? If decreased weight originates merely in an absorption of fatty tissue, and no strength is lost, the result is at least not unhealthy. But when other tissues are involved (and it would be difficult to decide when they are, as this doubtless varies even in the same individual), it is then, if not disease, closely allied to it—and certainly an indication of an impaired and debilitated physique, prone to succumb to other morbific agencies, and ultimately to induce premature decay and old age. Physiological in their earlier stage, they soon become of doubtful nature, and finally decidedly pathological. And that there is a special and not merely a general relation between these phenomena and the health appears, first, from the results being so marked, uniform, and generally prevalent; second, from concurrent indications of debility, shown by a progressive increase in the amount and severity of sickness; and, third, by a marked decrease in the loss of weight and strength in the tropics, when some of the agencies which indirectly augment its influence are removed, as will be proved by the following Table, which shows the effect of an improved diet.

During a similar voyage from England to the South Atlantic, in two of Her Majesty's ships, both crews were subjected to a corresponding amount of tropical weather; but the number of salt-meat days in H.M.S. 'Bristol' was twelve fewer than in H.M.S. 'Salamander' *, the result being that in the former the number of those who lost flesh and strength was reduced by 22 per cent.

TABLE XVII.—To contrast the results of two similar voyages on the weight.

	Total number weighed.	Number and percentage unchanged.	Number and percentage who gained.	Range of gain.	Average gain.	Number and percentage who lost.	Range of loss.	Average loss.
		per cent.	per cent.	lb.	lb.	per cent.	lb.	lb.
H.M.S. 'Bristol.' 65 days { 34 in the tropics, 38 on salt meat }	379	42=11·08	172=45·38	1–12	2·73	165=43·53	1–13	2·45
H.M.S. 'Salamander.' 55 days { 34 in the tropics, 50 on salt meat }	116	7= 6·03	33=28·45	1–13	4·18	76=65·52	1–23	7·2

[This was equally apparent among the cadets (Table XVIII.). Thus, of 58, the number who lost weight became reduced from 65½ to 40 per cent. by a removal from the tropics, combined with a limited use of salt meat. The improvement in their growth, as shown by their height and measurement of chest, was equally obvious.

* From a lately introduced issue of preserved meat every third day in the naval dietary.

TABLE XVIII.—To contrast the results of two voyages on the weight of Cadets.

	Number weighed.	Number and percentage who gained or did not lose.	Number and percentage who lost.
		per cent.	per cent.
A voyage to Bahia of 88 days:— in tropics, 66 days... on salt meat, 51 „ ...	58	20=34·47	38=65·51
A voyage to the Mediterranean of 100 days:— in tropics, 0 days ... on salt meat, 5 „ ...	57	34=59·64	23=40·35

The general loss of flesh (in other words, absorption of internal tissue) which results from the salt-meat dietary of long voyages, and which is here seen to be so greatly intensified in and by tropical climate, is really the essence and primary stage of scurvy, and corresponds in principle and nature with the visible, external, and superficial breaking down and loss of substance in the phlegmous abscesses, ulcers, &c., still too prevalent in the service, and in its more serious and advanced forms of the dysentery, and putrid ulcer, once so common and fatal; while the intensity, obstinacy, and sometimes the origin of many other local and general diseases frequent among seamen, *e. g.* rheumatism, syphilis, struma, various fevers, continued, contagious and periodic, &c., have doubtless an equally close alliance.—Feb. 27.]

These experiments were carried out in super-oceanic climates. It would be interesting to know how the weight and strength are affected in continental ones, where the range of temperature and humidity &c. are greater, as, for example, when troops are moved from the cool hilly regions of India to its sultry lowlands.

These facts suggest important hygienic and therapeutic indications; for example:—

First. That the tropics, especially during the rainy season, should be avoided by natives of colder latitudes.

Second. That the young, the debilitated, and the diseased should especially shun warm regions.

Third. That none but full-grown healthy adults should go there.

Fourth. That with all, even the latter, a speedy exit should be made therefrom, when great loss of flesh and strength give warning of approaching disease.

Fifth. That such injurious agencies as may increase the weakening or disease-inducing influences of tropical climates, of themselves irremediable, should be avoided, *e. g.* faulty diet, over fatigue, impure air, &c.

Sixth. That, to preserve health, a tropical climate should be frequently changed for the more temperate ones of higher altitudes or latitudes.

VI. *Conclusion.*

The ultimate object of these varied functional and organic changes induced in the human frame by change of climate, is to accommodate it to altered meteorological and other conditions, and assimilate it to those of native races. It is the ease or difficulty with which different varieties of mankind, ages, sexes, and idiosyncrasies become accustomed to this that indicates their capability for what we term acclimatization. [Would not a more intimate acquaintance than we yet possess with the differences in the minute anatomy and functions of the various tissues and organs of these different races and families, and also their correlation and capability or not of assimilation under change of climate, go far to decide the long-vexed questions as to the unity or plurality of species and of creative centres? —Feb. 27.] In these important changes, moreover, especially that in the current of the blood from the interior to the surface of the body on proceeding to the tropics, there is an evident analogy with certain great operations which take place under similar circumstances in the inorganic world. The air and ocean likewise heat as they proceed towards the equator, and finally overflow to form those beneficent winds and sea-currents which play so important a part in the economy of the globe, and influence its hygiene, therapeutics, and etiology, not less than its commerce. And although in these it acts on what may be termed the centre of their circulation, whereas in the human frame it operates on its periphery, the agent in all three is the same, viz. the sun's heat, as is the primary effect, viz. a change in the direction of original currents, as well as the final results, viz. purification and modification of temperature. The general physical and general hygienic and curative schemes of nature are thus evidently connected. Without these phenomena the heat of tropical lands and seas, and cold of other regions, would be intolerable, and that of the skin and body too high or too low for the maintenance of their vitality; while both the air, ocean, and blood would rapidly become impure and unfit to sustain life.

Deriving its first and chief impulse from the heart, the blood merely undergoes redistribution—the current in cold and temperate climates being directed towards internal, and in the tropics towards external organs, especially the skin. In either case it flows from cooler towards more highly heated regions. Is not this vital process, therefore, in this respect also, at least partly akin to the allied phenomena in the air and ocean, and physical as well as physiological? The blood generally being probably somewhat warmer in the tropics than elsewhere, does not the heating of the surface and contents of the turgid cutaneous capillaries act as a *vis à fronte* in inducing it to flow towards and accumulate here, as the warm interior does in cold regions?