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Wednesday, May 25th, 1859.

Captain PACKE, in the Chair.

The ACCLIMATION of EUROPEAN TROOPS for SERVICE in INDIA, and the ORGANIZATION there most SUITED to SECURE EFFICIENCY in the FIELD.

By JAMES BIRD, Esq., M.D. F.R.C.P., and late Physician General Bombay Army.

AMONG the mountain ranges of the western ghats of India, the Neilgherries, and elevated spurs of the lofty Himalayan chain, districts and climates, suitable for the healthy residence and vigorous existence of the European race, have of late years been eagerly explored, and as rapidly made the settlements of English invalid officials. The best known and most frequented of these hill stations are Aboo and Mahabaleshwar on the west, for the Bombay presidency; Ootakamund and the other Neilgherry stations for Madras; Darjeeling for Calcutta and Bengal; Simla, Nynce Tal, Landour, and Mussoorie, for Bengal and the north-west provinces; and Murree and Dalhousie for the Punjab. The experience of thirty years has established that the climate of these stations is congenial to the feelings and health of Englishmen, and that, as permanent residences, they are suitable for our population, in so far as their limited extent of territory permits; and that the out-door labours of settlers would not, for eight months of the year at least, be interrupted by the excessive rain-fall, which, for successive days of the four months of the Indian rainy season, is found amounting to 10 or 24 inches of rain daily. Along with the introduction, therefore, of the railway system into India, flattering schemes for the colonization of these hill stations, and the cantonment there of a large English force, have been perseveringly and glowingly set before the Government and the public, as encouragement for both to liberally subscribe their money for the practical completion of such schemes. Some of these recommendations, however, more particularly their military occupation as acclimating stations for troops, have been made without due knowledge and consideration of the physiological changes effected in the human body, under change of climate and locality; or of the hygienic conditions under which such changes, and the acclimation of Europeans, with the results of their efficiency for service in hot climates, can be most effectually obtained. In fact, the elevated table-lands, or plateaux, above which several of the hill stations rise, such as Dapoorie, on the same high plain as Poona, or 1,900 feet above the sea-level, have been somewhat incongruously spoken of as hill stations, and recommended, in the same breath with the last, for extended military occupation. But the conditions of climate peculiar to the former, and the organic physiological changes effected by residence there, which form individual constitutions suitable for hot climates, are altogether different from those experienced at higher elevations of from 4,000 to 7,000 feet; where elevation is accompanied by the same diminution of temperature as met with in temperate latitudes, or in this country, but from which European soldiers, after years

of healthy residence, would, on descending to the lower plains for military service, suffer nearly as much as if under direct and immediate transference from temperate to equatorial latitudes; where, as already recommended in my former lectures, the best means of assimilating the raw soldier's constitution to new employment and climate will be to remove, as far as possible, all local and topographical causes of unhealthiness; and to neutralise, at the same time, the hurtful agencies of extreme and variable temperature, or excessive dryness and humidity, by well-regulated systems of diet, clothing, exercise, and amusement, along with the healthy sites of the soldiers' tents, barracks, huts, and hospitals.

Certain increased ratios of sickness and mortality among masses seem inseparably associated with certain degrees of latitude; the average of human life, under equal circumstances, being shorter in proportion as we are near the equator, and lengthening gradually as we approach the pole. Such higher or lower averages seem mainly dependent, as a whole, on higher or lesser degrees of temperature and moisture connected with particular latitudes, and are inversely as the degrees of latitude. They are also relatively greater or less, in the inverse ratio of elevation of site and locality, when the diet, clothing, and social and moral habits of individuals are alike and placed under equally sanitary conditions of a dry soil, good drainage, and an open country, more exposed to sea than land breezes. The conservative influence of insular maritime climates is greater than continental sites in the same degrees of latitude, and is probably one reason why the per-centage of mortality for age in England is less than that of France. In the southern provinces of the latter country, where the climate is warmer, the average mortality of the population is a tenth greater than in the northern provinces, or 1 in 33 to 1 in 44; and yet it is not from the last, but from the former, that troops for service in Algeria are taken, as their constitutions, after a few years' residence there, are found better able to resist the morbid influences of a hot climate, and the disturbed physiological actions of constitution incident to all cases of transference from different climates and localities. To avoid, therefore, the probability of any great increase of the ratio of sickness and mortality, among troops under transference from cold to hot climates and localities, it is desirable that the transference should be effected at that season of the year when the conditions of climate and country to which troops will be exposed are found to vary least from those conditions characteristic of the climate and locality they have just left. In selecting, then, particular elevated sites and localities for military occupation in hot climates, the question is not one merely of the highest elevation, possessing climatic conditions of the temperate zone, and the consequently diminished chance of engendered malarious influence and sickness; but at what altitudes and in what localities of India, and other hot climates, can large bodies of troops be best cantoned and habituated to varied and elevated temperature; and to the moisture of these climates, so as to keep down high ratios of sickness and mortality among soldiers, and render them most efficient for service in the field. If the question was only one of colonization or permanent occupation, without chances of removal to service and fatigue in a warmer atmosphere, the choice, without any risk of failure or disappointment in result, might be given to the greatly elevated and colder hill climates of

India, met with at the height of between 6,000 to 8,000 feet. But, on the subject of military occupation and the cantonment of troops, it plainly resolves itself into conclusions from facts, as to the final results for armies best prepared for field service; or, in other words, what climates and localities of India are most calculated to effect that sanitary condition of European military masses, so as to render them least susceptible of morbid impressions, during exposure to heat and other causes of disease incident to field-service in that country: where, out of any given number of men, entering on such service, and accustomed to a hot climate, there will be the greatest amount of efficiency in the field, under a decreasing ratio of sickness and mortality. The answer to these queries, and their solution, mainly depends on a right appreciation of what essentially constitutes for strangers in a new climate, and under its modifying climatic agencies, that altered constitutional condition which ends in health for the new comer, with the possibility of living in and resisting the diseases of the country nearly as well as those who are indigenous to it. These modifying atmospheric agencies are temperature, density, moisture, and electricity; the nature and composition of the soil and locality, with its extent of casting, and proportion of continent or otherwise; which, continually acting on the body, effect in due time a special modification and interchange of organic functions, which adapt individuals and masses to the new conditions of their existence.

Some, from having confounded together two orders of agencies, the atmospheric and endemic or miasmatic causes of disease, absolutely deny the possibility of acclimating Europeans in hot climates. Mons. Baudin in France, Sir Alexander Tulloch and Mr. Martin in this country, incline to this view:—which is, however, opposed by the enlarged experience and well-considered opinions of Dr. M. Levy, MM. Celle, Perier, and Aubert Roche in France, and of many other experienced army medical officers in this country. Dr. Levy says, "According to the investigations of Sir Alexander Tulloch, it has been advanced that prolonged sojourn, far from promoting acclimation, increases the chances of mortality; and statistics, always pliant and flexible for every kind of paradox, have crowded their group of figures around this opinion. Soundly-observed facts refute it however. From 1,220 military who died in Algeria, and taken at random, three-fourths had not exceeded a residence of 17 months. We have also noticed the progressively numerical decrease of men discharged: for, out of 1,575 dysenteric cases that came under observation during 10 years in Africa, 388 belong to the first year, 235 the second, 150 the third, 86 the fifth, 35 the seventh, 17 the eighth, and 2 the last two years."*

These preliminary observations on the subject of localizing and acclimating European troops on hill stations in India bring me to the consideration of the three following heads of this lecture:—

1st. If acclimation be possible, what is the nature of that physiological adaptation of European constitutions for hot climates that assimilates them to the same standard of organic action incident to the organism of the indigenous inhabitants, and confers on them a nearly like immunity from certain diseases?

* *Traité d'Hygiène Publique et Privée*; par Michel Levy, Médecin principal d'Armée, &c. tome i, p. 568.

2nd. The elevation and condition of the stations and climates of India most desirable for placing European soldiers beyond the range of aggravated attacks of fever and bowel complaint, and most suitable for producing that kind of constitutional adaptation by which they may be rendered most efficient for field-service.

3rd. What practical lessons may be drawn from the consideration of these questions, and what organisation of European troops in India would secure most efficiency on service, and with greatest good to the State?

I shall endeavour to treat these points in a comprehensive but brief manner, still sufficient, I hope, to convey to my hearers definite ideas of a difficult subject; obscured as it has been, in some measure, by incongruous elements of morbid causation, such as yearly decrement of constitutional power by age, augmented by miasmatic influences of locality, not having been separated from atmospheric causes by those who obtained statistical figures and results, to prove that in hot climates there is no acclimation. But, if acclimation be possible, what are the proofs of it? I have already quoted the opinion of the well-known French army physician Dr. Levy, that according to his experience the contrary opinion of this is a paradox. Indeed, it is true only in this way, that the law of yearly increasing mortality from five years of age onwards, and which, for Europeans, prevails with the smallest ratio of mortality in temperate latitudes, when exaggerated by transference to equatorial latitudes, and other elements of increased morbid causation, not ameliorated by suitable sanitary arrangements for climate and locality, gives a large and continuously-increasing ratio of physical degradation and mortality. The operation of this law, among masses of men, gives the least statistical ratio per 1000 for the civil population of England, or a mean of 8.45; while in Prussia, France, and other continental states, it increases to 10. and 11.25 respectively. But the relatively mean ratio of mortality under this law, when sought for among the soldiers and officers of the English army at home, is 14.52,* and among those of the French army 15.10;† showing that the soldiers' separation from the influences of his natal place, climate, and association, increases on the whole his physical degeneration—even under home residence and climate. The mean ratios of mortality among the French military at home, and of English troops in Ireland, under this law, compared with the respective means for the troops of both nations under hot climates, are to be seen in Table III. The home ratios, having been calculated for years when the sanitary condition of soldiers was little attended to, are higher than those obtained from later years. What wonder, then, that under transference to equatorial latitudes, and augmented sources of unhealthiness unremoved, and not ameliorated by suitable sanitary provisions and arrangement, statistical figures and results should

* In the tables handed in by Sir Alexander Tulloch, in support of his evidence before the commissioners appointed to inquire into the organisation of the Indian army, the mean of cavalry and infantry is given at 15.52. The other table there, corresponding with No. VI. I have taken from Mr. Marshall.

† The mortality of Europeans under military life, and in increasing ratio according to residence and proximity to the 1st degree of equatorial latitude, is increased by advance of age, transition from native climates, transference to tropical latitudes, unremoved sources of endemic disease, and bad sanitary arrangements for soldiers in respect of their diet, barracks, clothing, and exercises.

have been obtained to speak so loudly against the possibility of constitutional acclimation, or adaptation of the nervous, circulating, and excretory functions necessary to contend against the changed conditions of life in a new climate. We may at once learn, by a reference to Table VII., how this law of yearly-increasing mortality for age, per 1000 of the civil population, operates in this country; and by Table VI. we may see how, by the same law, an exaggerated ratio of mortality takes place among the military on transference to our colonies. In latitudes north of the equator it is least in the Ionian Islands, being 19·8;* but in southern latitudes, under the rather hot climate of the Cape of Good Hope, and where but few sources of miasmata exist, it falls to 17·6, being only 3·8 above the mean ratio for this country.

"Change of climate," says Dr. Levy, "is to be born to a new life. Some changes become necessary in the vicarious or alternate functional action of the principal organs, in the regimen, and habits moral and social; but so complete ought these changes to be that they may be effected without necessarily producing either disease or death. The gift of elasticity of our fibres, the gift of extent of our functional oscillations, is conferred on us for accommodating ourselves to new influences collectively, in order to plant ourselves in every place where humanity is represented by some one of its numerous tribes. But this is under the condition of conforming to things necessary for the transition, and of combating, by attention to hygienic modifiers, the assaults of climate and irregularities of organic action. That the statistical mortality of Europeans in hot climates need not be a subject of exaggerated fears, we repeat that it proves less the radical unhealthiness of certain climates than the deleterious conditions, but correctible, of their topography, such as the existence of marshes, and vast masses of organic matter. It proves above all the baneful consequences of neglecting the laws of hygiene."

The operation of age, in diminishing constitutional vigour, and thereby increasing the yearly ratio of mortality among bodies of men, is sensibly felt and appreciable, under all conditions and in every quarter of the globe. The statistical results, therefore, of this operative law necessarily increase, in proportion as those subject to it are exposed to additional causes of morbid causation in hot climates, and such as have been mentioned; but, though we cannot altogether bring down the mean ratios of mortality of hot climates to the standard average of temperate ones, we have still within our power the removal of certain endemic sources of disease in localities, and to so train the changing organic functions of the body into a healthy state, under altered conditions of elevated temperature, for purposes of assimilating a majority of European constitutions to hot climates, and with results of having mean ratios of sickness and mortality among troops, not greatly in excess of those incident to our own country and like temperate zones. If this were not the case young soldiers in India, under exposure to elevated temperature and fatigue, would be quite as healthy as the old or seasoned ones; while the very reverse of such result is found to be the experienced opinion of old military and medical officers. The acclimation so acquired, and by which old soldiers

* In the second of Sir Alexander Tulloch's tables before quoted this is given at 16·4.

can outwork the younger ones on a campaign, is not mere experience gained by residence; but partially a physiological adaptation of constitution to new conditions of life, with improved physical qualities, for accommodating itself, under fatigue, to those conditions.

The adaptation to the changed conditions of hot climates, independent of miasmatic sources of disease, must be gradual and progressive for unacclimated masses of strangers, and imposes on them the necessity of shorter or longer sojourn in intermediate regions, with proper attention to moderate eating and drinking, selection of season for landing in the new climate most akin to that which they had just left, and, after arrival, fixing on habitations and localities free from miasmata, protected from land winds, and under the salutary influence of those from the sea; together with the resolute adoption of suitable diet, clothing, and exercise. Such care and attention become necessary, in order that certain organic functional actions, in more elevated temperature, may be reduced in force, and so regulated as to be brought into vicarious healthy action in place of others, and to aid some, lessened in power and activity.

At page 31 of the Appendix to Minutes of Evidence taken before the Commissioners appointed to inquire into the Organization of the Indian Army, Returns 34 and 35 are given, in illustration of the comparative beneficial results of transference of regiments to India, after sojourn in the intermediate climates of Australia or the Cape, and of direct transference from England. While the result of these Returns makes questionable the propriety of transferring troops from our Australian colonies, they bring out the benefit of doing so after a sojourn at the Cape. The mortality of five regiments sent from the Cape to India, after the first year of service, was 4·8 to 11·0 among eight regiments sent direct from England; and if the ratio of mortality for three additional regiments at the Cape be added to the former ratio, we obtain the comparative beneficial results of transference from the Cape and from England as 7·21 per cent. to 11 per cent. of their strength. Nothing can be more conclusive than this of the possibility and benefits of graduated acclimation to elevated temperature, apart from the miasmatic influence of locality. The superiority of residence at the Cape over the graduated influence of a sea voyage, is thus brought out. Acclimation too of troops in India, under suitable sanitary arrangements, as not only practicable, but an obvious result among old soldiers, when they have become seasoned, is further substantiated by many valuable facts brought forward in Mr. Willoughby's able and consistent evidence, given at p. 267 of the Commissioners' Report, as well as by much that is admitted in the evidence of the medical witnesses; for at page 171 of the Report, and in reply to Major-General Hancock's question, "Does not a greater mortality prevail among young officers and soldiers than among those who have been eight, ten, or twelve years in India?" Mr. Martin answers, "Yes, always; the mortality is greater among the young, the improvident, and, if I may so call it, the unseasoned. I am afraid to say anything which should lead to the conclusion that there is such a thing as acclimation; but that kind of accommodation of the habit and constitution occurs in every country in the world, not in India alone. The army of Napoleon broke ground from Boulogne in 1805, he marched 400 French leagues to the battle of

Austerlitz, they were all old soldiers, they were exercised, no room was left for idleness, and there were hardly any sick on the roads. When he went again, in 1809, to the battle of Wagram, the roads were lined with youths who perished." Is not this corroborative of the opinion I hold, in common with many celebrated physicians and physiologists, "that there is virtually a physiological adaptation of constitution to new conditions of life, with improved physical qualities?" This, too, is an adaptation which not only prepares them for greater fatigues during a campaign, but exempts them from attacks of many severe diseases incident to marching in hot climates, particularly cholera and sun-stroke. Regarding the exemption from the latter enjoyed by old soldiers, Sir Robert Vivian, in his evidence (p. 137 of the Report), adduces, in support of his opinion that Europeans can be seasoned, the superintending surgeon, Dr. Arnott's, medical experience, "that it was a somewhat remarkable fact of two European regiments engaged in the affair before Kooneh, on the 7th May, 1858, the right wing of H.M. 71st Regt., about 425 strong, had twenty men attacked with sun-stroke, of whom seven died, while the portion of the 3d Bombay Europeans, about 330 strong, had not only no casualty from, but no man attacked by, this disease, though both corps were equally exposed to the same causes of disease, and under circumstances apparently precisely similar. The 3d Europeans had an average service of three years in India, the 71st arrived in Bombay the preceding February, 1858.

Acclimation, then, in hot climates being admitted as a physiological and practical result, I come to the second part of the inquiry, "What should be the elevation and condition of stations and climates in India most suitable for producing that kind of constitutional adaptation, by which men may be made most efficient for field service?" Not certainly in the more elevated mountain climates of India, within the range of 4,000 to 7,000 feet, where diminution of temperature produces climates akin to those of the temperate zone, and associated with kindred organic functional actions of the body as are met with in those; except that calorification and respiration are less energetic from the diminished density and oxygenation of the air, while the processes of sanguification and nutrition are more venous and incomplete, with a greater concentration of blood in both the lungs and digestive apparatus. Their limited extent, too, may scarcely admit of large bodies of soldiers being acclimated there, and it would be found on experience that, like the indigenous inhabitants of these mountain ranges, Europeans so localised, when brought down from the hills for service in the plains, during the rains and hot weather, would be quite as sickly under the transference, and die in as great relative proportions as men brought direct from England. Elevation of site in equatorial latitudes is accompanied by nearly like climatic conditions as are met with in the temperate zone, and with the same preponderance of certain functional actions of the organism as distinguish its inhabitants and vegetable productions. Special modifications and interchange of these functions would be as necessary, under transference to the elevated temperature and other altered climatic conditions of the plain, as when required for improving the health of Europeans, recently arrived in India.

On this subject Sir George Clerk, in his evidence, page 195 of the Commissioners' Report, says, that locating European troops on the

mountains of India is a false measure; and that with good barracks placed at certain commanding points on the plains of India, they would be more healthy than they are in the West Indies, or in many other colonies. If by commanding points he means, such dry sandy plains as Deesa, or the high plateaus of Poonah, Belgaum, Dharwar, Bangalore, and such like elevated places in the Bombay and Madras presidencies, I entirely concur with this opinion, that with good barracks, and under suitable sanitary arrangements for diet, clothing, and exercise, the ratios of mortality per 1,000 would be so reduced as not to exceed those of temperate climates. In all of these places, much of their healthy character is evidently due to the dryness of the site. At Deesa, in the northern military division of the Bombay presidency, where the elevated temperature sometimes exceeds 110° of Fahrenheit, the ratio of mortality, for 10 years, 1847-57, was 21·9 per 1,000; at Poona, 10·7; at Belgaum, in the southern division, 19; at Bombay, 55·5; and at Bangalore, in the Madras Southern division, 23·8. At Aden, in Arabia, a very dry locality, but hot climate, the ratio per 1,000 is only 25·2. Soldiers cantoned at elevated sites, ranging from 2,000 to 2,500 feet, would be more efficient in the field, and more able to bear up against hardships and exposure on actual service, than those stationed at higher elevations and under conditions of climate more nearly akin to those existing in the temperate zone.

Stations of this kind, where large bodies of troops may be cantoned and acclimatised for Indian service, are everywhere available through the wide extent of the Bombay and Madras presidencies. Selection of moderately elevated sites for Bengal proper, that may be rendered healthy for troops, by means of good drainage and well-constructed barracks, is a matter of more difficulty, from the general flatness of the country: but for the north-west provinces, many eligible and elevated sites may be chosen for locating European troops. Dryness of site, gravelly character of soil, and freedom from masses of organic matter, should be always of the greatest importance in determining a preference of selection for such stations.

Mere elevation of site, without other essential conditions of endemic health, will not necessarily secure low ratios of mortality for troops. Reference to Tables IV. and V. for the ratios of mortality according to elevation of site in the tropical latitudes of the east and west, indicates that at elevations much higher than that of Poona, and other like healthy localities, where, from the nature of the soil and site, endemic sources of malarious disease are allowed to exist, the ratios of mortality per 1,000 will be still found very great, and little or at all below those attainable for troops localised on the plains—facts sufficiently instructive in guiding us to the most necessary sanitary arrangement for soldiers in hot climates, namely, to select, for their barracks or encampment, eligible sites and localities, where there is no accumulation of surface-drainage, and no relative sources of miasmata in the vicinity.

In the Madras presidency, the average ratios of mortality for five years will be found least in the presidency and Mysore divisions of the army, including Bangalore, being respectively 25·5 and 23·5. Within the ten military divisions of that presidency, though there are some very elevated sites, still they are most unhealthy from those endemic sources of disease we have mentioned, and there are many others that

might be yet selected with great advantage for the localisation of troops. Among the elevated but unhealthy sites within this presidency, it will be instructive, on this subject, to notice that in the Mysore division the sites of Seevasamoodrum and Seringapatam, elevated about 2,000 feet, have been found very destructive of European health, while many other localities of the same division, peculiarly productive of fever in former times, have since become perfectly healthy; and in others the very reverse has taken place, shewing the main sources of European unhealthiness are endemic miasmata, and not mere elevated temperature, to which the human organisation adapts itself. Seevasamoodrum is surrounded by water and jungle, and near one of the falls of the Cavary. In other districts of this presidency the ravages of fever and other miasmatic diseases are not stayed, even at an elevation of nearly 5,000 feet, where their endemic sources are allowed to exist. In the Travancore province of the southern division a considerable plateau of table-land, 4,740 feet high, and in the vicinity of Trevandrum, but not yet thoroughly explored, is said to be healthy. Again, in the Salem district of the same division, the table-land of the Shivaroy hills, at a general elevation of 4,600, and but scantily clothed with vegetation, is not beyond fever range after falls of rain. During the dry months they have been found perfectly healthy; but the breaking out of a fatal remittent form of fever among the European residents there, during June, 1824, caused them to be deserted. It is not mere elevation then that we have to look to for European health in India, but to an eligible and perfectly well drained and dry site for European soldiers.

I come now to the third and last point—What practical lessons may be drawn from the consideration of these questions, and what organisation of troops would secure most efficiency on service, and with greatest good to the State? The previous observations made, and the statistical facts adduced in proof, that old and seasoned soldiers are superior in endurance and physical qualities to young unseasoned ones in India, have partly anticipated the solution of these problems. Lord Ellenborough in his evidence, p. 293 of the Commissioners' Report, fully bears out this opinion in the statement that he saw 100 men of the 9th Lancers, who had never seen an enemy, die within the first year of their residence in India. At the utmost strength of cavalry regiments this would be fully a sixth of their strength. The possibility of acclimating troops to mere elevated temperature being possible, and the adaptation of their constitutions being followed on service by lessened ratios of sickness and mortality, form one of the strongest grounds for a considerable organisation of European troops for local service in India; independent of those financial and political considerations, which, for the ultimate safety of our Indian empire, strongly urge on us the necessity of this measure. It is not within the province of this lecture to discuss the financial and political bearings of the question, that there should be a large permanent European force maintained in India, and proportioned to the moveable force of the British Army, always subject to the periodical reliefs from home. The permanent force should be at least two-fifths of the moveable force—say 32,000 to 48,000 men of the regular Army, from among whom, on being relieved to return home, European colonists for hill stations, and recruits for the permanent local force, might be obtained.

In concluding the exposition of the medical questions that have been mooted, we may draw the following inference:—

1st. That the law of constitutional deterioration—greater mortality for age in hot climates, beyond the ratios of like age in temperate ones—can be greatly reduced in operation by removing endemic sources of disease, and by selecting suitable dry localities.

2nd. That in the most insalubrious tropical countries, the selection of good positions, on dry elevated table-lands, suffices often to secure for European troops a perfect sanitary state, nearly equal to the more salubrious regions of the temperate zone: this salubrity varying, however, in a remarkable manner with the geographical latitudes and longitudes of places.

3rd. That the increasing ratios of mortality for hot countries mainly depend on unremoved surface drainage, and the generation of miasmata in places occupied.

4th. That the morbid influence of seasons and climates in producing disease is in direct relation to and dependence on the quality of the soil, the latitude, the longitude, the elevation of the place, its northern or southern exposure, and the national temperaments and races of soldiers who may be there located.

TABLE I.—GENERAL MORTALITY of the ENGLISH ARMY at HOME and ABROAD, from 1819 to 1828.

Years.	Effective Strength in the United Kingdom.	Deaths.	Ratio of Deaths per 1,000.	Effective Strength beyond the United Kingdom.	Deaths.	Ratio of Deaths per 1,000.
1819	53,380	493	9	51,992	3,755	63
1820	51,527	740	11	50,557	2,584	57
1821	37,988	620	16	51,277	2,220	42
1822	41,530	560	13	46,709	2,692	57
1823	40,786	566	13	48,995	1,981	40
1824	42,535	651	15	49,883	2,257	45
1825	57,048	854	16	53,755	3,849	71
1826	48,826	1,082	22	53,339	4,513	77
1827	47,747	824	17	53,440	3,713	63
1828	46,193	828	18	58,592	2,844	47
Total . .	470,610			531,534		

TABLE II.—MORTALITY of ENGLISH TROOPS from WAR, and under TRANSITION to OTHER COLONIES.

Places.	Authorities.	Period of Observation.	Annual Mortality per 1,000.
Cape of Good Hope	Official Reports, 1818 to 1836	1818 to 1836	15·5
New Scotia and New Brunswick	Ditto	1817 to 1836	18·
Malta	Ditto	1817 to 1836	18·7
Canada	Ditto	1817 to 1836	20·
Gibraltar	Ditto	1818 to 1836	22·1
Ionian Islands	Ditto	1817 to 1836	28·3
Mauritius	Ditto	1818 to 1836	30·5
Bermudas	Ditto	1817 to 1836	32·3
St. Helena, 1816 to 1822, and from 1836 to 1837	Ditto		35·
Tenasserim Provinces	Ditto	1827 to 1836	50·
Madras Presidency	Quetelet	1826 to 1830	52·
Bombay ditto	Ditto	1826 to 1830	55·
Bengal ditto	Ditto	1826 to 1830	63·
Ceylon	Official Reports	1824 to 1836	57·2
Antilles and Guiana.	Ditto	1817 to 1836	85·
Jamaica	Ditto	1817 to 1836	143·
Bahama	Ditto	1817 to 1836	200·
Sierra Leone	Ditto	1819 to 1836	483·

TABLE III.—COMPARISON of the MAXIMA and MINIMA of MORTALITY of FRENCH and ENGLISH TROOPS in TEMPERATE and HOT CLIMATES.

TEMPERATE CLIMATES.				HOT CLIMATES.			
Periods and Departments of Service.	Mortality per 1,000.			Periods and Departments of Service.	Mortality per 1,000.		
	Maxi- mum.	Mini- mum.	Mean.		Maxi- mum.	Mini- mum.	Mean.
FRENCH. Infantry for 6 years in France, 1820 to 1826	23	15	19·4	FRENCH. In Algeria 5 years, 1838 to 1843	104·	49·	76·5
ENGLISH. Troops in Ireland 32 years, 1797 to 1823	20	10	15·	ENGLISH. In the Antilles and Guiana 19 years, 1817 to 1836	152·3	40·6	96·7

TABLE IV.—INFLUENCE of ELEVATION and LATITUDE in DIMINISHING the RATIO of MORTALITY among EUROPEANS in HOT CLIMATES.

Countries and Latitudes.	Stations.	Elevation in feet from the Sea.	Mortality per 1,000.	Remarks.
Saint Lucia, 13° 50' north	Mount Fortunate	850	122·	Deducting deaths of sick brought there, only 22
Jamaica, 17° to 18° 30'	Up Park Camp	200	152·8	
	Stony Hill	1,360	96·	
	Maroon Town	2,000	32·	
Ceylon, 6° only of north lat.	Kandy	1,670	60·7	
	Badula	2,100	97·1	In 1849 only 16 per 1,000·
	Nieur-Elia	6,200	24·	
Mysore	Bangalore	2,400	22·	
Neilgherry Hills, in lat. north 11° 10' to 11° 32'	Ootakamund	7,116	20·	

TABLE V.—INFLUENCE of PROLONGED SOJOURN in INCREASING the MORTALITY of HOT CLIMATES.

Places.	Length of Sojourn.	Periods of Age.	Mortality per 1,000.	
Ceylon . . .	Below 1 year	—	44·	The mortality here given is only of one Regiment, the 72nd, of which the effective strength is unknown; but still progressively increasing in a country where malarious influences on mortality is scarcely appreciable.
	1 to 2 years	—	48·7	
	Beyond 2 years	—	49·2	
Jamaica . . .	Below 1 year	—	77·	
	1 to 2 years	—	87·	
	Below 2 years	—	81·	
	Beyond 2 years	—	93·	
Cape of Good Hope .	3 years	—	8·	
	4 ditto	—	13·	
	5 ditto	—	12·	
	6 ditto	—	16·	
	7 ditto	—	18·	

TABLE VI.: from Mr. MARSHALL.—INFLUENCE of AGE on the ANNUAL MORTALITY of every 1,000 EFFECTIVE MEN among ENGLISH TROOPS at HOME and ABROAD.

Places of Residence.		Mortality per 1,000 from Age.				Mean Mortality per 1,000 at all Ages.
		From 18 to 25 Years.	From 25 to 33 Years.	From 33 to 40 Years.	From 40 to 50 Years.	
United Kingdom	Cavalry of the Line	13·9	14·	17·8	26·7	15·3
	Horse Guards	14·7	11·4	16·3	22·8	14·5
	Foot Guards	22·3	22·5	17·7	27·5	21·6
Gibraltar		18·7	23·6	29·5	31·4	22·3
Malta		13·	23·3	34·	56·7	22·3
Ionian Islands		12·2	20·1	24·4	24·2	19·8
Antilles		50·	74·	97·	123·	67·
Jamaica		70·	107·	131·	123·	91·
Bermudas		16·5	42·	42·	76·	28·9
Canada—Upper and Lower		19·7	27·7	37·7	35·7	25·7
New Scotia and New Brunswick		14·	22·5	30·8	41·5	20·3
Cape of Good Hope		9·	20·6	29·7	82·	17·6
Mauritius		20·6	33·	52·7	86·7	34·7
Ceylon		24·	55·	86·4	126·6	48·3
Bombay		18·2	34·6	46·8	71·1	33·1
Madras		26·	59·3	70·7	86·5	52·2
Bengal		23·8	50·3	50·6	83·3	44·5

TABLE VII.—MEAN ANNUAL PROPORTION of MORTALITY among every 1,000 LIVING INDIVIDUALS of the ENGLISH CIVIL POPULATION above 4 YEARS of AGE, 1838 to 1841.

Age.	Ratio of Mortality per 1,000 Living Males of every Age.	Age.	Ratio of Mortality per 1,000 Living Males of every Age.
Under 5 years	70·97	From 60 to 70 years	43·60
From 5 to 10 "	9·48	" 70 " 80 "	91·93
" 13 " 15 "	5·24	" 80 " 90 "	201·73
" 15 " 20 "	7·30	" 90 " 100 "	461·93
" 20 " 30 "	9·91	" 100 and above	454·79
" 30 " 40 "	11·30		
" 40 " 50 "	15·00		
" 50 " 60 "	23·01		
		General Mean	23·16