THE SPINE PAD: A DISCARDED ITEM OF TROPICAL CLOTHING
AN HISTORICAL AND PHYSIOLOGICAL SURVEY
BY
E. T. RENBOURN, B.Sc., M.D.
Formerly Major, Royal Army Medical Corps
From the Directorate of Physiological and Biological Research, Clothing and Stores Experimental Establishment, Ministry of Supply.

INTRODUCTION

The spine pad has become a dull museum piece, and it is probable that specimens are nowadays not easy to find. Yet to those living in tropical areas during the early part of the century and to those serving with the British Army in hot climates during the First World War, memories may be evoked of a piece of cloth of cotton, silk or wool, plain or quilted, several inches wide, attachable to the shirt or coat along the spine, and sometimes with a coloured lining. It is now difficult to accept that this mere piece of cloth could in any way protect from the effects of the sun. But the purpose of the spine pad was so closely linked with the development of ideas concerning body heat, fever and sunstroke, that one must be prepared to explore many early lines of thought for an understanding of its origin and its demise.

SIRIASIS AND PHRENITIS—THE EFFECTS OF THE SUN

From the dawn of history it has been recognized that rays of the sun could seriously affect the body, and early examples of sunstroke are found in the
The Spine Pad: a Discarded Item of Tropical Clothing

Bible, in Greek mythology and in Chronicles of the Crusades. The term "siriasis" has been used since the time of Pliny to denote, in general, maladies arising from exposure to the great heat of the sun during the summer solstice when the dog star Sirius shone brightly in the sky. Stephen Blancard, in his *Physical Dictionary* of 1693 (7), defined siriasis as an "Inflammation or rather Heat of the Brain or its Membranes occasion'd by the Heat of the Sun. This is frequent in Children because of the Thinness of their Skulls." The word "phrenitis" was employed from classical periods onwards to denote almost any disorder of the brain associated with excitement or frenzy. After the Middle Ages it frequently became associated with maladies arising from exposure to the sun.

At the beginning of the eighteenth century the Dutch physician Boerhaave wrote on the post-mortem findings in cases of sunstroke. "The true phrenitis," he said, "is from lying with the head to the hot rays of the sun . . . such as died from the phrenitis and were open'd after their decease, had their meninges inflam'd; a gangrene, imposthume and a sphacle of the Brain, or some sharp corroding and ichoriac matter" (8). For almost a century after this, sunstroke was often confused with apoplexy, but it was generally agreed that in hot climates the important causal factor was the sun or wind.

In 1826 John Davy, brother of Sir Humphrey Davy and assistant director of army hospitals, investigated the ability of the sun's rays to penetrate the cranium. He noted that "when the sun's rays are concentrated by a lens, they penetrate . . . through bone, as a portion of the cranium; through nine folds of black crepe; and what is more extraordinary, through rolled platinum. It was easy to ascertain their penetrating through the former substance by a luminous point appearing on a surface beneath. This circumstance may help to explain the effect of the sun on the brain, in producing the malady commonly called coup-de-soleil" (20). It is clear that Davy used a dried skull bone in his experiment, and his results were hardly applicable to a living cranium covered with skin and hair. These findings of Davy's may, however, have turned the thoughts of tropical practitioners to the necessity of protecting the head from the sun's rays.

THE "HAVELOCK" OR WHITE CAP COVER AND NECK CURTAIN

The value of a white colour for reflecting solar heat can be traced to the physiologist John Mayow (1674) (57). By 1744 the French Army surgeon De Meyseray was already putting this into practice in the form of white leather helmets. Discussing the effects of the sun's heat, he noted that "these dangers can be prevented by the use of white leather. Experience has shown that white bodies have the property of reflecting the sun's rays, and our white leather will be sufficiently impenetrable to these rays to prevent those unhappy accidents the fatal outcome of which we have too often noted" (59).

A few years later Benjamin Franklin made the phenomenon more widely known. "Walk but a quarter of an hour in your garden," he enjoins, "when the
sun shines, with part of your dress white and part black; then apply your hand to them alternately; you will find a great difference in the warmth. The black will be quite hot to touch. . . . Summer hats for men and women should be white for repelling that heat which gives head-ache to many, and to some the fatal stroke that the French call coup-de-soleil" (29). In 1787 the British Army introduced for tropical use a white felt top hat ornamented and cocked according to pattern, and on and off after this the black shako had a white linen cover (32). Robert Jackson, an early reformer of army hygiene, said in 1791 that for Jamaica "round white hats would be a proper covering for a soldier's head" (46). It is, however, not clear that these were always worn to keep the soldier's head cool. Bache, in 1836, showed perhaps for the first time that the effect of a white colour applied mainly to solar heat, and colours made but little difference in reflecting the non-luminous rays of the animal body (3).

From earliest times fear of the sun's rays must have sometimes urged the soldier or traveller to wear down the back of the neck a white handkerchief or handy piece of cloth. The official introduction of a neck curtain, however, appears due to Sir Henry Hardinge, who, in 1842, prior to leaving for India as Viceroy, ordered white cap covers for tropical use, to which was added some time later a white neck curtain (65). Within a few years the Sikh wars had broken out, and old prints of battle scenes show that a white cover and neck curtain for the shako and forage cap were in use at the battles of Ferozeshah (December, 1848) and Mooltan (January, 1849) during the hot days of the winter season (53), (37). At the battle of Ferozeshah, General Gough noted that the British soldiers "were clothed in ordinary scarlet uniforms, blue trousers, and wore forage caps covered with white cloth and a curtain hanging down behind for protection of the head and neck . . . greatcoats were not carried" (37). In 1852 Assistant Surgeon Lamprey, of Her Majesty's 15th Regiment in Colombo, recorded the results of his experiments in an obscure pamphlet entitled "98° or 130°, or the Infantry Soldier in the Tropics". At this early date Lamprey was using a thermometer for measuring the temperature inside clothing and headgear. The results led him to conclude that a white cover to headgear would keep the cranium cooler in a hot climate. However, he made no mention of a neck curtain (51).

Old prints demonstrate that by the time of the Indian Mutiny the use of a neck curtain was fairly widespread. The frequent use by General Havelock of the combination of a white cap cover and neck curtain no doubt led to his name being associated with this form of headgear. Both officers and men of Neill's "Blue Caps" wore neck curtains at the storming of the Char Bagh battery and at the relief of the Presidency (83). Records of the "King's Own" contain the following order of 1858: "Wicker helmets covered with white cotton to be worn with puggarees with ends hanging down as a curtain" (19). Reference to the early interest in the neck curtain by the French Army is given by Martin, who in 1859 (56) noted that Scouettenten of Algeria was at that time pre-eminent among French physicians in urging the necessity for its use. Judée in 1863 (49) was instrumental in introducing the couvre nuque or neck curtain into the French Army. Morache wrote in 1874: "Recently the cap and white neck
The Spine Pad: a Discarded Item of Tropical Clothing

curtain have become regulation, but this happy addition is not sufficient. The idea was first introduced by the British Army into its uniforms” (62). The German military hygienists, Roth and Lex, were, like Morache, great admirers of British clothing and equipment, and in 1877 commented on the Nackenschurz or neck curtain as follows: “The simplest protection consists of the white cover and neck curtain of the forage cap. This was first used in 1842 by English troops serving in India” (69). In 1899 Captain Freeman, R.A.M.C., in his Sanitation of British Troops in India (30) noted that “a quilted curtain at the back of the neck has sometimes been used on service, but it is very heating to the neck.” Nevertheless a neck curtain of a grey or khaki colour continued to be used by the British Army in most tropical campaigns.

In the official history of the Medical Services in the First World War, the following is found concerning the campaign in Mesopotamia: “Slouch hats had been provided with puggarees and neck curtains... The slouch hats were, however, replaced by tropical helmets. Steel helmets were also provided with covers and neck curtains” (86).

PHYSIOLOGY AND PATHOLOGY OF THE SPINAL CORD: EARLY NINETEENTH CENTURY

During the beginning of the nineteenth century doubt began to be cast upon the apoplectic nature of heat stroke. Lindesey, in 1835, noted that “the train of symptoms no doubt much resembles that of apoplectic seizure, but the post-mortem appearance far more resembles that in asphyxia from the poison gases” (52). A year later Russell added that “the brain was healthy in all cases; no congestion or accumulation of blood was observed... but in all three cases the lungs were congested even to blackness throughout their entire extent” (70).

Although pathologists were in general doubting the importance of the brain as the prime seat of sunstroke, experimental work and clinical observations were reaffirming its importance in body heat regulation and in fever. The early studies of Benjamin Brodie concerning the effects of spinal section in animals were published in 1811 (9) and 1812 (10), and produced the conclusion that the nervous system was the source of animal heat. For this work he was awarded the Copley Medal of the Royal Society. However, the conclusion was soon criticized by his teacher, Sir Everard Home (44), who stressed that although injury or disease of the brain or spinal cord could induce fever, these parts of the nervous system were not the main source of animal heat. Chossat (18), in France, stimulated by Brodie, continued the latter’s investigations, but inferred that the seat of heat production was the sympathetic nerve which lay on either side of the spinal cord. Claude Bernard (1857) (5) suggested that destruction of the sympathetic nerve caused vasodilation and an increase in local heat production, but his colleague Brown-Séquard (12) reasoned that the results could be explained entirely on circulatory changes. Practitioners in hot climates were not slow in applying the new physiological concepts to the pathology and prevention of sunstroke—a condition long known to be associated with an ardent fever and a burning skin.
Fig. 1. Mooltan: the Assault, 1849

Two officers are seen wearing white cap covers and white neck curtains. A dark neck curtain is also seen.
E. T. Renbourn

On the clinical side, Brodie (1837) (11), Billroth (1868) (6) and Hutchinson (1875) (45) demonstrated that although in men the results of a spinal cord injury were equivocal, pyrexia and hyperpyrexia sometimes resulted. It was becoming clear that the brain and spinal cord were in some way concerned with body heat regulation. Aitken, Professor of Pathology at the Army Medical School, in his *Handbook of the Science and Practice of Medicine* (1858) (1), quoted Army Surgeon Marcus Hill of India, who two years previously had found compression of the medulla oblongata in cases of sunstroke and who had suggested that such a lesion was the cause of the pulmonary congestion.

DEVELOPMENT OF THE SPINE PAD: NINETEENTH CENTURY

Neither Aitken, Martin nor earlier tropical practitioners mention the necessity of protecting the spine against the sun, and no evidence has been found for the use of a spine pad of any sort in tropical campaigns up to and including the Indian Mutiny. In 1858 Julius Jeffreys noted that, "although the head is undoubtedly by far the most sensitive part of the body, the spine is also sensitive" (48). Jeffreys believed the abdomen was also affected by the sun and advised a sun curtain for its protection. He was, however, doubtful of its practical value and concluded: "It is freely admitted that a question may be raised whether a front curtain can be so suspended as not in the smallest degree to interfere with the evolution of the musket" (48).

Jeffreys spent some thirty years in India, holding appointments as Staff Surgeon at Cawnpore and Civil Surgeon at Futtehguhr. He was a personal friend of Martin, to whom his *British Army in India* was dedicated. In this book Jeffreys put forward the novel concept of body heat loss by radiation, evaporation, conduction and convection. For protection of the spine he suggested as follows: "We may suspend behind it, at a distance of some inches, an apron or curtain composed of two or three layers of Jean or other doubly woven linen or cotton cloth. We can certainly reduce the solar influence by half by this means. But there is no reason why we should rest satisfied with materials so deficient in virtue. Why should we not determine to command a bright metallic surface?..." (48). Although some of Jeffreys' ideas were highly impracticable, his views on the possible value of metalized fabric for reflecting heat were revolutionary. For many years he tried to persuade the East India Company to put his inventions to the test, but without success. When eventually tried in India, they were a failure (65). The suggestion of Jeffreys—now almost a century old—for a "climatic" chamber trial of his invention is, however, a remarkable example of a designed experiment. "Happily," he said, "it is not necessary to account for a comparative trial in India. By means of two planished tin or other metal mirrors, rays of an open fire may be reflected upwards to the ceiling and then down again. Two men may be placed side by side as to be subjected to them equally. One may be clad in the usual manner and the other in the manner proposed. It will soon appear which of them is drawn away from his post. The men may then be dressed in succession."
Another name in the early history of spine protection is that of Surgeon (later Surgeon-General) Moore of the Bombay Medical Service, who served in the Mutiny with the Rajputana field force. In 1862 he wrote that "the sun exercises as injurious an effect on the organic sympathetic system through the medium of the spinal column and the solar plexus... as it does on the brain... and this has been observed by many medical officers. Hence the importance of a turban shading the upper part of the medulla spinalis and of a cummerband worn round the loins" (61). Some time earlier Moore [quoted by Gordon (35)] suggested that good spine protection could be obtained by prolonging the neck curtain down the back and tucking it in at the waist. Although in India the villagers normally had no head cover, native soldiers were to be seen with a prolongation of the turban flowing over the shoulders, the whole back or even extending as far as the knees. European observers had looked too often for a physiological function in the dress and customs of the indigenous inhabitants of hot climates and they may have sometimes assumed that either the turban or its curtain was worn by natives for the protection of the head or spine. It is, however, doubtful whether the custom had anything but an ornamental value. Indian women did not wear a turban.

Parkes wrote in 1864: "It is quite possible as usually assumed that, with a bad head-dress, the heat of the skin and bones or even the nerve centres of the brain and spinal cord may be greater than accord with a perfect temperature of the body" (65). Army Surgeon Gordon stated in 1859 (35) that the proximate cause of heat stroke was a loss of balance between the cerebrospinal and sympathetic nervous system. In his text-book published in 1866 he added the following: "There are many medical officers who with the author believe that on the march or during great exposure to the sun, more danger exists of heat apoplexy occurring in consequence of direct solar heat upon the loins, giving rise to spinal congestion, than from the effects upon the head. During the Mutiny in India, not a few officers suffered in this respect while sitting in the saddle during a day's march in a westerly direction, that, of their own accord, they had recourse to a cummerband, or girdle of thick folds of cloth; and with good results. This may account for the native Indian habit of wearing large masses of cloth round the loins. In the case of horses in India, their keepers, while leaving the heads of the animals uncovered, invariably place carefully upon their loins several folds of horse cloth which they usually carry with them as if for this purpose" (36).

In spite of continued preoccupation with the effects of the sun on the head and back, practitioners in India and elsewhere had often reported the fact that sunstroke (insolation, heat stroke, coup-de-soleil) could occur out of the tropical sun—at night, in barracks and tents—and in hot furnaces and stoke-holds. Furthermore these expressions were sometimes used loosely to mean almost any effect of the sun, including sunburn and even prickly heat. Severe sunburn was also known to occasion an "irritative fever," and this may have helped to confuse it with sunstroke.

Professor Wood of Philadelphia realized as early as 1863 (80) that sunstroke was, in the main, a disturbance of temperature regulation, and as a
consequence introduced the expression "thermic fever." From his later researches on animals (81) he concluded that sunstroke arose from general overheating of the body, and stressed perhaps for the first time that selective heating of the head was not the essential cause. Little notice, however, was taken of this important finding for some thirty years.

Sir Joseph Fayrer was present at the siege of the Presidency during the Indian Mutiny, and may have seen Neill's "Blue Caps" wearing the "Havelock." In 1875 he was attached to the suite of Edward Prince of Wales during the tour of India. In his Recollections Fayrer gives the following entry concerning the Prince of Wales's party: "all are provided with light clothing and with quilted pads along the spine" (26). A member of the Royal Family thus wore spine protection thirty-five years before it was officially introduced into the British Army. In the Practitioner of 1876, Fayrer wrote that "heat stroke is due to syncope and a shock-like condition in which, from the direct action of heat on the brain and cord in exposure to the sun's rays, the nerve centres, especially the respiratory centre, are implicated causing rapid failure of respiration and circulation" (25). In 1875 Koester, looking for post-mortem changes in the nervous system in a case of heat stroke, found hæmorrhage into one superior cervical sympathetic ganglion and swelling of the other (50). Another mention of the nervous system in heat stroke, but as so often on clinical grounds only, was that of Preston (1887) (67), who stated that the condition was a specific meningitis arising from sun exposure. In 1897 Déjerine demonstrated microscopic changes in the blood-vessels and ganglion cells of both the brain and spinal cord in heat stroke (21).

Andrew Duncan, surgeon in the Bengal Army, published in 1888 a textbook on military medicine (22) which had won for him the Parkes Memorial Prize for 1886. This book is still of great value to the student for the details given of hygiene during various military campaigns. Talking of sunstroke, he noted that "the spinal cord, according to Moore, is always largely implicated. A thick woollen spinal pad must be worn sewn into the coat. This is only rarely observed in the campaigns, but I hold the protection of the spine in hot climates to be of equal importance to protection of the head. In the Afghan War, I observed only a few in use among the officers and none among the men." The use of a spine pad was, at this time, probably not a question of regimental regulation, and this item of tropical clothing was still not to be officially introduced into the British Army for some twenty years.

In the first edition of his text-book of tropical medicine (1898), Manson wrote that "a pad of cotton sewn on to the coat is a wise measure adopted by experienced sportsmen in India" (54). In the following year, Hobhouse in his Medical Handbook of Travel commented as follows: "Some recommend the wearing of a spine pad . . . For those who are likely to have long marches, they may be advantageous" (42). In 1903 Harford, on the other hand, noted that "a spine pad though recommended by some, is hardly necessary . . . and Sir Harry Johnson says it collects perspiration" (38). Attention having been drawn to the necessity of protecting the back, it is not surprising that "spinal"
symptoms should have developed. Thus Giles (1904) commented: “Many persons are wellnigh as sensitive to insolation of the spine as of the brain, and suffer at once from the exposure of the back to the sun’s rays . . . many find that the sun playing on this part of the person causes a dull heavy aching, an oppression rather than a pain. Persons subject to such symptoms should wear a broad pad of the same material as the coat, thickly padded with cotton-wool” (34). Nowadays the symptoms would no doubt be accepted as psychological and ascribed to fear of the sun. The physicians were undoubtedly much to blame for “spinal insolation.”

THE ACTINIC THEORY OF SUNSTROKE
At the beginning of the twentieth century attention was being devoted to an actinic theory of sunstroke and to its prevention by the use of coloured linings. For an understanding of this strange chapter of tropical hygiene and the confusion surrounding it, some further ideas concerning the effect of colours on the body must now be considered.

In 1744 John Mitchell of Virginia, in his long essay “Causes of the different Colours of People in different Climates” (60), suggested that the immunity of negro skin to sunburn and prickly heat was not due to its colour “which retains more Heat than a white one, but to a Concretion of its Vessels and Glandules which renders the Skin both thicker and denser.”

Within two years of the discovery of “invisible” heat by Herschell in 1800, Ritter found rays beyond the violet end of the spectrum capable of demonstration by the “photographic” method of Scheele—the blackening of silver salts. In 1821 Sir Everard Home (43) noted that painting a white skin black gave protection from sunburn, and suggested that the black rete mucosum of the negro was the natural defence. When, like Mitchell and Franklin, he found that “a black surface absorbed heat and raised the temperature beyond any other . . . he . . . gave up the matter in despair.” Writing on the same topic five years later, John Davy (20) added: “I have made experiments similar to those of Sir Everard Home, and with the same results. All the opaque colours of which I made trial, applied to the skin, whether red, orange, blue or green, have afforded protection from the scorching influence of the sun’s rays equal to that afforded by black.” Davy realized that Home’s findings were rather misleading in that the efficient sweating of the negro skin was not taken into account; and added, without proof, that “in the tropics, the cuticle appears to be thinner . . . so as to confine the animal heat less.” Neither Home nor Davy appeared to be aware of the newly discovered chemical rays.

In 1833 Stark (76) put forward the theory that colours have a selective effect on the absorption of odours. This was passed from one book to another and led to the belief that dark clothing absorbed not only body emanations but also noxious effluvia from the air. Jaeger (47), elaborating the theory some fifty years later, believed that red garments could, in this way, produce rheumatic pains and other ills.
The first application of the knowledge of the chemical or actinic rays to man was the work of Brücke (13) on the effect of "invisible violet light" on the eye. It was, however, not until 1858 that the French neurologist, Charcot, writing on the skin erythema arising from exposure to electric arc lamps, postulated that both electric erythema and the erythema of coup-de-soleil were due to the chemical rays (17). Although an astute clinician, Charcot, like many others, used the term coup-de-soleil (sunstroke) to mean erythema solare or sunburn, and may thus, by a confusion of terms, have laid the seed of the actinic theory. Moore, in 1862 (61), was perhaps aware of the work of Davy and Charcot when he wrote the following: "When rays are absorbed by a dark surface, they lose their peculiar power and cease to be radiant and induce sunburn or inflammation. Such factors lead to the opinion that in hot climates, two colours should be used at the same time; white for the outer garments exposed to the sun's rays and dark for the underclothing to prevent rays acting injuriously on the skin." Moore may also have confused sunburn with sunstroke. It is otherwise not clear why he suggested the use of dark underclothes, since it had always been well understood that ordinary clothing, whatever its colour, was sufficient protection. No reference was, however, made to any earlier work. In 1867 Robinson (68) carried out experiments on heating the hand immersed in water (to absorb heat rays) by concentrated solar rays. He concluded that the sunburn so obtained was not due to the "calorific element," and added: "Whether or not actinic or chemically active rays or whether any active power related to electricity is the cause must be left to future research." In 1885 the German dermatologist, Paul Unna (77), showed that rays capable of pigmention the skin existed only in the ultra-violet region of the spectrum.

The next stage in the development of the actinic theory is outlined by Andrew Duncan (23). It appears that Major F. N. Maude, executive engineer serving in India, pointed out that "no one gets heat stroke when the luminous rays possess no degree of chemical energy as in the furnace of an arsenal. The actinic rays can not only produce a superficial dermatitis with pigmentation of the skin, but can effect chemical changes under the skin. Maude showed next how dark red or yellow will intercept actinic rays, as every photographer knows. He therefore, so far back as 1885, began to use a red or yellow lining to his head covering and coat, proceeding for the same reason that photographers develop plates with the aid of red or yellow light. He found the resulting relief so great and surprising that he communicated his ideas to his brother officers, in every case with the happiest results. Maude finally submitted a report to Headquarters in Simla." It was not till 1901 that Maude published his ideas as a letter in the Indian newspaper Pioneer. In 1887 von Schmædel, apparently independently, came to conclusions similar to those of Maude. His ideas were published in a paper (entitled "Why are Negroes Black?") given to the Anthropological Society of Munich; von Schmædel said that "nature acts exactly like the photographer when he seeks to protect his sensitive plates from the chemical action of light... Pigments of a light colour neutralize the heat rays but let the chemically active pass unhindered, whereas black pigments permit heat rays to pass but stop the
On this hypothesis he attempted to explain the matter vexing John Mitchell in 1744—the relative immunity of dark skins to prickly heat.

Although it is true that at the temperature of an arsenal furnace little or no ultra-violet light is produced, it has already been pointed out that heat disorders did in fact occur under such conditions. It is not clear what Maude meant by "chemical changes under the skin," but presumably they were the cause of sunstroke and related disorders. The "relief" that Maude and his brother officers obtained from protective colours was probably from some form of headache which can be nowadays explained only on a psychological basis. In 1897, Lord Roberts clearly stated that he had found coloured linings of no particular value.

Almost up to the end of the nineteenth century the term actinic was used rather loosely by photographers to mean any radiation capable of affecting their plates, the sensitivity of which was, at this time, almost entirely due to visible blue and violet light. Although plates were also sensitive to what is now understood by ultra-violet light, the amount produced by the light source of a dark room and passing through coloured glass must have been non-existent. Since the plates in the dark room were sensitive to visible light and the supposed cause of sunstroke was invisible rays, the analogy used by Maude and von Schmædel can hardly be said to have had a scientific basis.

In 1898, two years after the application of Röntgen rays to the human body, Manson (54) wrote: "The phenomenon connected with the Röntgen rays suggests the possibility that there may be solar rays other than ordinary heat rays which although able to pass organic materials can nevertheless be arrested by metal. If this be true for the sun as for the electric spark, a useful addition to the sun hat would be a thin plate of light metal." There was no reference, however, to the use of coloured linings.

In 1901 Captain Munson of the American Army said that "with a better knowledge of the character of light, it has been suggested that actinic rays are a strong factor in the production of insolation. This can be arrested by a layer of colour used as a filter. Dark red, yellow, or green are protective and the material or thickness is of little importance. A lining of such a colour is recommended for the head cover and for the blouse over the spine" (63). The source of this information is not given.

During the short period between reading the letter in the Pioneer and returning to England in 1902, Andrew Duncan, greatly impressed by Maude's ideas, put theory to practice by lining his sun hat and spine pad with orange coloured flannel and by wearing an orange coloured shirt and vest. Prior to this, he had suffered from three attacks of the sun characterized by "excruciating pain in the head coming regularly as soon as the sun had risen and lasting all day until the sun had set. Nothing relieved them . . ." However, after using the protective clothing, Duncan (like Maude) insisted that he afterwards experienced no bad or distressing effects of the sun (23). What sound conclusions can be drawn from this statement is left to the reader!
Using photographic and radiometric techniques, he carried out experiments on the transmission of solar radiation and artificial ultra-violet light through various body tissues and textile fabrics (71), (72). In 1903 Schmidt found that very little ultra-violet light penetrated deeper than the surface of skin or textile fabrics, and pointed out that in the clothed man insufficient reached the skin to produce even sunburn. He concluded that actinic rays were of no importance in sunstroke (71). Little notice was taken of this important finding for a number of years. Giles, in 1904 (34), said of children, “their little skulls appear remarkably easily penetrated by the Y or Z rays, causing sunstroke” but gave no details of these fictitious rays. In the following year Professor W. J. R. Simpson, one time Medical Officer of Health at Calcutta, noted that “the injurious effects of the sun are believed caused more by chemical than heat rays. For this reason red, orange or yellow coloured fabrics which do not allow chemical rays to pass should be worn. Natives of hot climates are fond of these colours and may have learnt from experience their comfort” (75).

Major Woodruff of the American Army, evidently unacquainted with Schmidt’s results, had become a firm disciple of the actinic theory. In 1905, writing of the protection afforded by the skin of coloured races, he remarked that “all these colours indubitably enable the native to conserve heat as well as the white man, and at the same time to exclude the dangerous chemical rays. The underclothes should be opaque, and black is best although yellow will do . . . it explains the wonderful tendency to wear black clothing which we see in many hot climates. They are actually cooler than white garments of equal weight . . .” Woodruff, like Giles, reiterated in somewhat modified fashion the earlier assertion of Blancard and Davy: “. . . it is surprising how transparent the scalp and skull are to light waves” (82). Considering how much was known about the reflecting power of a white colour for solar heat, Woodruff’s remarks on black clothing—based on speculation alone—show the continued confusion of ideas.

In 1908, Duncan, apparently unaware of Schmidt’s refutation of the actinic theory, read a second paper on insolation (24) to a meeting of the United Services Medical Society, held at the Royal Army Medical College. Maude—now a Colonel—had been invited as an honoured guest. Duncan outlined the latter’s early work, but neither Charcot, Moore, von Schmadel nor Munson received mention. The discussion after the meeting is well worthy of notice. The various theories of insolation were put forward and received a certain amount of support, but the actinic theory was generally adopted by the audience. Eloquent testimony was given as to the value of orange-red as a protective colour, and a singlet-type garment was recommended having an incorporated spine pad. The following dangerous statement was put forward by Duncan: “In the old pattern red army uniform the sun was less powerful for harm than it is with modern dress.” Dr. Sambon, also of the London School of Tropical Medicine, was present at the meeting and elaborated his new bacterial theory of sunstroke, but as far as the rest of the meeting was concerned this hypothesis “did not have a leg to stand on.” In the same year another paper on the actinic theory was published by Colonel R. J. S. Simpson (74). After critical examination of available
data, the author concluded that the "evidence for the theory was not always as strong as the language in which the theory was expressed."

About this period "Solaro" and "Assolar" cloths—a logical outcome of the actinic theory—were being used for tropical clothing. Both were thin materials; on the one side khaki or white in the warp to reflect solar heat, and on the other side black, red or orange in the weft to absorb actinic rays. "Solaro" was of English manufacture. The origin of "Assolar" cloth—the German equivalent—is not known.

A year before the appearance of Duncan's second paper, Lieut.-Colonel Wood, Inspector-General of the Philippine Division, American Army, had called attention to the experience of British Army officers in India as to the value of coloured linings in the prevention of heat disorders, and had suggested that these be put to trial in the Philippines by American scientists. During the years 1909-1910 Gibbs (33), Freer (31) and Bacon (4) of the Philippine Bureau of Science carried out investigations on atmospheric ultra-violet light, and found that its intensity was most variable and sometimes no greater in Manila than in temperate zones. It was shown that it was the chemical nature of a dye and not necessarily its colour that was the absorbent factor of ultra-violet rays. Schmidt, in 1909, had independently come to the same conclusion. He also showed that there was no particular virtue in the so-called actinic proof colours of "Assolar" and "Solaro" cloths. By this time the term actinic light was losing its association with visible blue and violet light and becoming synonymous with ultra-violet rays. In 1901 Phalen (66) carried out a physiological trial in the Philippines on a thousand American soldiers wearing orange and white vests. An elaborate series of physiological measurements (red and white blood cell count, pulse-rate, blood pressure, etc.) and a questionnaire were used. The results showed, in general, no objective difference in health or physiological measurements between men wearing white and those wearing coloured garments. A series of papers was soon published by other American workers—Wickline (1908) (78), Chamberlain (1911) (16) and Aron (1911) (2). Again it was concluded that no evidence was present to validate the actinic theory. Aron's experimental work on monkeys is of interest in that it confirmed Wood's results of 1872, and showed again that selective heating of the head was of little importance in sunstroke.

In 1910 Castellani and Chalmers exposed animals with shaved heads to the sunlight of Colombo, using red glass to screen off ultra-violet light (15). Their unexpected conclusions were that heat stroke was due to the visible blue and violet rays—the actinic rays of the older photographers. Pardy-Lukis & Blackham (64) noted in 1911 that since all effects of sunstroke could be attributed to infra-red rays, elaborate precautions by way of two layers of clothing of different colours were superfluous. In the same year, Colonel Hehir (40), noted that although coloured underclothing had the advantage of not showing the dirt, the dyes used might be conducive to a number of skin disorders. Colonel Havard of the American Army was first an adherent of the actinic theory. However, in 1914 (39) he wrote as follows: "The application of non-actinic colours to the soldiers' uniform presents difficulties. Orange red is too conspicu-
FIG. 2. Mesopotamia
Preparing a trench mortar. Soldier wearing a triangular spine pad and a neck curtain. Secure attachment of pad to chest by tapes.

FIG. 3. Mesopotamia
An advanced signal post in a trench. Both men are wearing oblong spine pads, each attached to the waist by cord. Neck curtains also worn.
FIG. 4. Mesopotamia

Straw mats being used as a shade for a howitzer in action in the desert. Only one man appears to be wearing a spine pad, which appears to be almost identical with the issue item of 1940. It is clear that the belt loop was not always used. Neck curtains are not seen.

Front View  
Back View

FIG. 5. Spine Pad, Army Model, 1940  
(Loaned by D.I.C., M.O.S., Branston)
ous in colour to be used as a lining to the blouse or for undergarments in hot countries where the soldier is inclined to discard his underclothes. The protection does not depend only upon the colour of the fabric but also upon its thickness and the tightness of its weave.

Although the actinic theory of sunstroke had received a serious setback in the early work of Schmidt and the later investigations of the American workers, the new knowledge was to disseminate slowly; and those travelling to hot climates continued to buy spine pads with coloured linings and to add them to their tropical kit. Furthermore, the British Army decided, at long last, to adopt the spine pad officially. In the 1909 Regulations for the Clothing of the Army (88), Table 8, a reference is given for the first time to “Pads, back, for European non-commissioned officers.” The Priced Vocabulary of Clothing and Necessaries of 1911 (87) shows a similar entry. There is no evidence that the British Army spine pad ever had a coloured lining, and it does not appear that a spine pad was officially used by continental armies.

THE FIRST WORLD WAR

In the First World War, the British Expeditionary Force went out to Mesopotamia armed with the “helmet Wolseley and pagri, chin strap, spine pad and dark glasses” (92). Perusal of the profusely illustrated The Times History of the War (91) shows but very few photographs in which a spine pad can be clearly seen on a soldier’s back, but a number of examples are to be found in the photographic records of the Imperial War Museum. The pads were of an oblong or triangular shape (base of triangle over the shoulders) and appear to have been buttoned or clipped to the shirt, and kept in position by tapes tied round the chest or waist. Only one brief mention of the spine pad can be found in the official history of the Medical Services (86); but Willcox, consulting physician to the Expeditionary Force, writing later (79) of his experiences of sunstroke, accepted the value of spine protection.

Shaklee, in 1917 (73), repeated Aron’s work on monkeys, and like most of the workers in Manila concluded that the only radiation of importance in sunstroke was in the infra-red region of the spectrum. Yet, two years previously, Puntoni in Italy [quoted by Byam and Archibald (14)] again insisted that the human cranium could be penetrated by ultra-violet rays. In 1918, McKenzie and Le-Count in the United States, published a clinical study of heat stroke (58). The authors stated quite categorically that no evidence existed for actinic or any other rays apart from heat rays playing an important role. Leonard Hill, in 1919 (41), repeated the work of Schmidt and showed that neither in a topee nor in a straw-board box lined with red or white material was a photographic plate affected by the sun’s rays. He also concluded that actinic rays were of no consequence in heat stroke. Nevertheless, Hill (as did Parkes half a century before) suggested that local heating of the head or spine might result from sun exposure and continued to recommend the value of head and spine protection.
THE LAST OF THE SPINE PAD

Conflicting opinions are found in the text-book on Tropical Medicine edited by Byam and Archibald (1923) (14). Balfour accepted the value of a spine pad but added that there was no special advantage in having it made of red cloth. Professor Simpson, reiterated his previous remarks on the value of coloured linings. On the other hand, some army authorities were now beginning to doubt the value of spine protection. Colonel MacArthur writing in an official memorandum (1924) (85), noted that "spinal pads are useful if only they engender a feeling of comfort and safety."

In 1930 Marsh (55), working in Persia, reinvestigated the earlier studies of Wood and Aron, and once again demonstrated that if the body of an animal was kept cool, exposure of the shaved head to tropical sun did not produce sunstroke. When the body was exposed but the head kept cool, the animal generally died, with the usual post-mortem findings. At last it was fully confirmed that sunstroke was not due to the effect of the sun's rays on the head, and critical observers suspected that neither the head nor the spine required protection. However, there is no evidence to suggest that, at any time in its long history, the spine pad was put to physiological trial under appropriate climatic conditions.

It was not to be expected that the spine pad would disappear forthwith, particularly from the British Army that had waited so long for its acceptance. In the Official Regulations for the Clothing of the Army of 1936 (89), the pad received the more imposing title of "spine protector," but nevertheless was but rarely used in tropical zones.

With the Second World War, the spine pad made a brief appearance. It was being produced in England in 1940, and there is some evidence that it was occasionally worn in India as late as 1942. Zachary Cope, writing in the official history of the Second World War on the subject of heat disorders, found that "there was difference of opinion as to the need of protective topees and spine pads. Some called them relics of superstition" (84).

CONCLUSION

During the life history of the spine pad many changes were taking place in the prophylaxis of heat disorders. Over-indulgence in food and alcohol was becoming frowned upon; tight thick uniforms and strangling stocks were slowly discarded; soldiers were less often exercised in the sun or incarcerated in stifling barracks during the heat of the tropical day. Fear of the sun diminished with the realization that its rays could not penetrate into the nervous system.

Faith, magic and empirical treatment have played their role in the development of the art of medicine. In medieval times it was believed that red cloth had sympathetic attraction for blood and humours and could protect from the scars of smallpox. The magic of a red colour remained until Victorian times as the old mother's tale concerning the power of a red muffler in the cure of a
sore throat. In 1893 Finsen (28) produced equivocal evidence to show that smallpox scars did not develop when the patient was nursed in red light. At the beginning of the present century Maude, Duncan and others were convinced of the efficacy of a red or orange colour as protection against sunstroke. Nevertheless, this belief must now follow the others into the limbo of superstition.

Spine protection is no longer a subject for discussion amongst students of climatic physiology. A century-old chapter in the history of tropical hygiene is closed.

ACKNOWLEDGMENTS
I wish to thank Mr. F. N. L. Poynter and the staff of the Wellcome Historical Medical Library, Mr. D. W. King of the War Office Library, and Mr. M. Davies of the Royal Army Medical College Library for valuable assistance in the search of some of the documents referred to in the text. The Imperial War Museum gave permission to publish photographs, at Figs. 2, 3 and 4.

REFERENCES
The Spine Pad: a Discarded Item of Tropical Clothing

34. GILES, G. M. (1904). Climate and Health in Hot Countries and the Outlines of Tropical Climatology. London.
45. HUTCHINSON, J. (1875). Lancet, 1, 713.
48. JEFFREYS, J. (1858). The British Army in India. Its Preservation by an Appropriate Clothing, Housing, etc. London.
51. LAMPREY, J. (1852). 98° or 130°, or the Infantry Soldier in the Tropics. Colombo.
71. SCHMIDT, P. (1903). *Arch. für Hygiene*, 47, 262.
72. SCHMIDT, P. (1909). *Arch. für Hygiene*, 69, 1.
85. (1924). *Memoranda on Medical Diseases in Tropical and Subtropical Areas*. H.M.S.O.
87. (1911). *Priced Vocabulary of Clothing and Necessaries*. H.M.S.O.
88. (1909). *Regulations for the Clothing of the Army*. H.M.S.O.
89. (1936). *Regulations for the Clothing of the Army*. H.M.S.O.
90. (1897). *Report of the Committee Appointed by the Secretary of State for War to Consider the Various Patterns of Headdress*. War Office Confidential Papers.
92. (1917). *War Clothing Regulations (Regular Army)*. H.M.S.O.