MILITARY HYGIENE

FOR

OFFICERS OF THE LINE

BY

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FOURTH EDITION
REWRITTEN AND GREATLY ENLARGED

NEW YORK
JOHN WILEY & SONS
LONDON: CHAPMAN & HALL, LIMITED
1909

Stanhope Press
F. H. GILSON COMPANY
BOSTON, U.S.A.

NOTE TO THE FOURTH EDITION

In its original form this work was an abstract in detached paragraphs of lectures on Military Hygiene given at the Infantry and Cavalry School at Fort Leavenworth, 1886–'90. It is now recast much after the style of those lectures, with such revision as the regulations and the progress of sanitary science require and it is sympathetically offered to the Line of the Army and to the National Guard. The constant effort has been to answer the natural inquiries of a line officer solicitous about his men. Subjects that belong exclusively to the medical staff have been omitted.

An essay upon the care of troops in the field, prepared at the beginning of the Spanish war, is retained, revised and slightly extended, because the convenience of concentration seems to justify a repetition of what is somewhat disconnectedly set forth in earlier chapters.

A work like this must be the expression of common knowledge and can make small claim to originality, but continual indebtedness is gratefully acknowledged to Parkes, to his immediate successors, and to contemporary workers in this field. Prolonged experience has tempered the opinions expressed.

ALFRED A. WOODHULL.

AUGUST, 1909.

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MILITARY HYGIENE FOR OFFICERS OF THE LINE

I

NATURE AND IMPORTANCE OF MILITARY HYGIENE

Military Hygiene: the Care of Troops

The ordinary definition of Hygiene is, a system of principles for the preservation of health, and of Sanitation the application of those principles. Military Hygiene is a conventional term covering both the principles and their practice as applied to an army, and a comprehensive and satisfactory alternative designation is the Care of Troops. In the wider and better sense every military condition, exclusive of the active operations of the firing line itself, is more or less affected by this department of knowledge whose final cause is military efficiency. In the last analysis physical vigor is the agency through which martial enthusiasm and intelligent discipline become effective under the direction of competent generals, and as the success of a campaign depends upon hostile contact, actual in battle or potential in manœuvres, so vigorous men are required for these operations. Every feature of military supply and every act required or permitted of a soldier, has an ultimate bearing upon the fighting capacity of the individual and thus collectively of the army. Hence the adequate care of troops is a serious and constant duty, often prosaic in detail, which may be neglected but cannot be renounced, whose reward is the development first of the simpler units, then of the higher organizations, and finally of the army itself. As a rule the efficiency of a command represents the intelligent attention it has received. The supervision of the soldier's life, not degenerating into irritating nagging by a weak and unstable superior, which is almost as bad as contemptuous neglect, is an ever-present duty for the company officer and is to be maintained in broader range over all the higher groups. For recruits, and especially for volunteers abruptly transferred in large numbers from civil life to the field, direct supervision is particularly required. The responsibility of the officers in immediate command increases with the necessary restriction of the men's freedom of action under their new and unavoidable limitations. That responsibility is not confined to instruction or orders under arms, but runs cöequal with authority over every condition and detail of military life. This conception of an officer's duty is very difficult for the men to realize and accept at first; and newly-appointed officers do not themselves always appreciate that they are the guardians and protectors, as well as the rulers, of the rank and file. The officers are the agents of the state, and the late Professor Parkes very clearly expressed the moral situation and the practical duty arising from it, thus: "The State employs a large number of men, whom it places under its own social and sanitary conditions. It removes from them much of the self-control with regard to hygienic rules which other men possess, and is therefore bound by every principle of honest and fair contract to see that these men are in no way injured by its system. But more than this, it is as much bound by self-interest. It has been proved over and over again that nothing is so costly in all ways as disease, and that nothing is so remunerative as the outlay which augments health and in doing so augments the amount and value of the work done." The health of the enlisted men is in great measure conditioned by the food, the shelter, the clothing, the exposure, and the innumerable circumstances and requirements which, for good or ill,

Supervision

Duty of officers

are arbitrarily controlled by the officers of one grade or another who exercise command.

Health

In theory healthy and vigorous men, such as those who may be supposed to make up an army, if subject to no pernicious influence from without, should always remain healthy and vigorous until disqualified by injury or by the gradual decay of age. The exceptions, negligible in a wide review, are certain malignant diseases, as cancer, and inherited infirmities, as gout or nervous disabilities, which usually develop later than the period of enlistment and whose immediate causes are not discernible by our present knowledge. It is the province of sanitation to avert the physical deterioration of properly selected men, or at least to minimize the harmful conditions to which the exigencies of the service may subject them. Conceding that there would be no sickness under ideal conditions, the practical relation that morbidity rather than mortality, the sick report than the death roll, bears to the efficiency of an army is important.

Morbidity

Morbidity, that is the sick rate, is one of the indices of military availability. Sickness, whether in garrison or in the field, means an expenditure of money and vital energy, multiplied in modern times by humanitarian care and by refusal to turn adrift the temporarily disabled. There is no prompt substitute for a man who is ill, whether present or absent. Besides the unavailability of the invalids, their care drains the resources of the living and very seriously limits the mobility of the command. Typhoid fever, for example, even when not fatal represents a loss of at least three, and often of six, months' service; dysentery is very liable to recur and, recurring, to persist; certain infections will run through a command, putting whole organizations off duty; and all these happen with no corresponding, or necessary, loss to the enemy. On the other hand, the fatalities of action simply create vacancies which recruits may fill, while the wounded at least do not act as centres for the spread of other disabilities, and the casualties of battle carry the presumption of proportionate hostile damage. Hence the activity of an army may be less interfered with by the sudden death of a number of men than it would be by their prolonged illness. Bearing in mind that disease is not spontaneous in the true sense, that all of it follows the operation of a cause and that the most is due to extraneous interference, it is the province of sanitation to control the sick-rate. Where that is large, it reflects upon the administration of the company or superior officers; or it shows that there are conditions to be altered or avoided, unless imperative military considerations compel endurance. The treatment of the sick is the immediate province of the medical officers, who should also be equipped with the full theory of preventive medicine, qualified to explain what should be done to avoid such ineffectiveness; and it is particularly necessary that in his exercise of command the line officer should remove the indirect as well as the direct causes of ill-health. The military hospitals that show a high admission-rate but a low death-rate usually indicate unnecessary agents of disease and a skilful clinical force; but where the admission-rate is low an efficient military administration is usually combined with natural or artificial sanitary advantages. When the medical officers invite attention to the physical causes of ill-health, especially to such as are obscure, their opinions should receive respectful consideration. But every officer of the line should possess among his qualifications for command not merely appreciation of the importance to the troops of vigorous health, but a general knowledge of the ordinary conditions which interfere with it. Because an army is a vital machine, its effective operation demands careful and constant recognition of whatever may affect that vitality.

Command and sanitation

II

DISEASE AND BACTERIA

Disease

Diseases are not distinct entities which may be introduced into the system or be withdrawn from it as such. The popular impression that a fever, an inflammation, or other actual disease enters the body substantively, and may be manipulated or destroyed, be driven out, independently of physiological processes, is a misapprehension, although it is a convenient form of speech. The basis of truth in it is that the disturbance of bodily function which is called disease is frequently set up by foreign material, by something alien to the body itself. The disease is not imported, but it is due to the operation of an imported agent. This distinction, which is more than a verbal one, is necessary to remember. Thus, cholera as cholera is not transferred from one person to another, but there may enter the body a microscopical agent which, later, induces that group of symptoms called cholera. The importance of the distinction lies in the fact that the disease-cause, not the disease itself, may be destroyed while in transit from one victim to another or it may be completely avoided. An individual attack, or an epidemic, is averted by the destruction of, or escape from, the invisible agent while it is yet out of the body. These physical antecedents whose introduction is followed by disease are numerous and diverse. Thus, consumption is due to a minute organism which excites local and destructive inflammation in the lungs or other part of the body where it may lodge; tetanus, or lockjaw, to another; diphtheria to another; and so through a considerable list. These disturbing organisms are of a low order of

Germs

vegetable life known as bacteria. An entirely distinct class, also capable of inciting serious diseases, are animal in origin and are called plasmodia (singular plasmodium). Taken together these infinitesimal objects are commonly but unphilosophically called "germs." The germ is not the disease, but it sets the disease in operation; as the coral insect does not wreck the ship, but the coral reef for which it is responsible may destroy the vessel. It is not to be understood that all diseases are as yet recognized as due to such causes, but there are so many and these so grave which do depend upon them (and the list is constantly growing), that an outline knowledge of their character is necessary for the understanding of some of the principles of sanitation.

Bacteria

All animal and vegetable life, that is all organic life, is carried on by the functioning of minute cells. Bacteria (singular bacterium) is a general name for infinitesimal plants, whose subdivisions are bacilli, cocci, and so forth, and these under favorable conditions multiply prodigiously. The most of them are beneficent to man by disintegrating dead organic matter and setting at liberty such chemical elements as they do not use for themselves. The decomposition of carcasses, the direct nutrition of growing vegetation, the fixation of free nitrogen from the air for supply of plant-growth, are accomplished, and accomplished only, by bacterial action. In view of the great multitude of bacteria comparatively few species are pathogenetic, that is, are disease-producing and hurtful to animal and especially to human life. These are of special types and of various degrees of virulence, and they effect their mischief by the generation of products known as ptomaines, or toxins, whose action leads to disease. Some of these hurtful bacteria are specific and lead to particular illnesses, and others act merely as temporary irritants. It is probable that in many cases there is sufficient natural vigor to withstand the more common of the hurtful bacteria, so

Toxins

that only those persons who for the time or constitutionally have less than normal resistance succumb to them. Otherwise such a disease as consumption, taken as an example, would be still more prevalent than it is. It must be that in most cases the bacillus of tuberculosis is destroyed or neutralized within the body before it makes a lodgment. But many such bacteria overcome all natural defence.

Anti-toxins

Immunity from a second attack of the contagious diseases which most commonly prevail over those who are first exposed, probably depends upon a positive change in the circulating fluids, due to the presence of anti-toxins generated during the first attack. Acting upon this theory, an antagonistic condition artificially creating immunity may be established in certain diseases, of which tetanus and diphtheria are good examples, by the injection of an anti-toxin artificially developed in the lower animals. Through such means persons not yet attacked but liable to exposure also may be rendered immune, and epidemics threatening wide disaster be aborted. Although bacteria do not float free in the atmosphere, they are practically omnipresent because they adhere to all animate and inanimate objects, particularly to dust, buoyant or at rest, to furniture, to clothing, and to the human body. They are so microscopically small that any visible aërial mote may bear multitudes. They are more numerous in proportion to the abundance of filth, and although filth in itself does not seem to create malignancy, it does afford special opportunity for the development of malignant bacteria once they are established. Some varieties of bacteria antagonize and destroy others, and all require for their activity moderate heat, moisture, available oxygen, and organic matter. When conditions are unfavorable to active bacterial development, the vital properties may concentrate into what is known as a spore, and the spores may remain for indefinite periods inert but capable of being aroused into

Omnipresence of bacteria

Conditions favorable to bacteria

Spores

Conditions unfavorable to bacteria.

renewed activity. Natural cold does not, but heat near the boiling-point of water moderately prolonged does, destroy their vitality. Scrupulous cleanliness is unfavorable for the development of bacteria; appropriate disinfectants directly applied either destroy them or limit their multiplication so as materially to lessen the risk; and sunlight, direct or diffused, particularly in the absence of moisture, is an efficient disinfectant, or, as commonly styled, germicide. Mere deodorizing, or masking the foul smell of the filth which may foster disease-causes, is not to be mistaken for disinfection, nor will time and exposure to sunlight in dry air always secure safety. These general facts, as the essential reason for that cleanliness which characterizes the better troops, should always be remembered and acted upon.

III

GENERAL REQUIREMENTS FOR SERVICE

The whole military fabric rests upon the physical character of those who compose it, for neither enthusiasm nor intelligence may be substituted for vigor of body and mobility of limb. Nevertheless, along with physical fitness the recruit should possess a sufficiently alert mind for the development of the individual self-reliance and dash which are replacing the older confidence of solid ranks and the momentum of armed masses. No precise measure of intelligence can be formulated beyond the official standard of literacy and the required testimonials of character, but care must be taken to exclude men who appear incapable of appreciating the improved weapons and of discharging the responsible duties of the modern soldier. To accept men of known bad character works injury to the service by admitting those sure to make trouble; and the occasional effort of civil authorities to purge their communities of undesirable characters by presenting enlistment as an alternative to imprisonment, is an insult to be resented in behalf of the rank and file and an offer to be rejected however stalwart the applicant. That is, the material must be selected; for not every chance applicant is fit for enlistment, and accepted recruits must be capable of becoming qualified for the sustained effort which war more and more insistently demands. The popular assumption that every full-grown man who supports himself by severe manual labor may, on that account, become an efficient soldier, is not true. Although he may be accustomed to vigorous work, the applicant's joints may not be flexible, his senses may not be keen, and sometimes his internal organs may not

Physique

Intelligence

Character

Selection

Strength alone insufficient

be sound. A man who accomplishes a great deal of labor by following his own methods may nevertheless be entirely unfit for the ranks, so that, misled by evidence of strength, an inexperienced officer sometimes mistakes gross vigor for special fitness. With attention, an officer of the line may satisfy himself, as presently to be pointed out, of the mobility of the joints, of the absence of disqualifying cranial injuries, of the range and quality of vision and audition. He may do more and determine the character of the man's breathing and his vital capacity, which together constitute the most important factors in the make-up of a recruit.

Recruiting officer's inspection

When recruits are most in demand, particularly as new regiments are being sent into the field, there is frequent temptation to relax the necessary rules; an error which always weakens the organization. It also happens that second-rate men sometimes are enlisted by special authority on account of their skill as craftsmen, but such can never be depended on in the field and will certainly be absent in battle. It also occasionally occurs that inferior men are accepted because of pressure to fill rapidly a particular command. Usually there will follow greater pressure for the discharge of those very men, and this cannot be successfully resisted if the enlistment was inconsiderately permitted. When in doubt about a recruit, the cardinal rule is to reject. There is a moral obligation to enlist no man whom the recruiting officer would be unwilling to have in his own company. Some grace may be extended toward men with blemishes contracted in a previous enlistment which do not affect organic soundness, who reëngage within the definite period which limits reënlistment. That is because their training, their habits of discipline, and their acquaintance with the military life compensate for non-vital physical deficiencies. But a blemished ex-soldier who has allowed the period for technical reënlistment to lapse, should only be accepted in peace after very careful consideration;

Lowered standard

Reënlistments

because the presumption is that he returns to the colors as a last resort, and not from a natural bent. In every instance all variations from the standard, whether they are natural or artificial, should be carefully noted on the enlistment papers. Vegetius, writing of the Roman forces in the year 300 A. D., declared that "an army raised without due regard to the choice of recruits was never yet made a good army by any length of service." That is as entirely true now as it always has been, and recruiting is therefore a serious duty to be conscientiously and intelligently executed, for "an army consists of the bayonets in the field, not the names on the muster-roll."

Vegetius

Importance of recruiting

IV

MILITIA, VOLUNTEERS, CONSCRIPTS

Besides and behind the regulars and the volunteers, the permanent and the temporary troops to whom this book chiefly applies, is the militia. In general terms all male citizens and male residents who have declared their intention to become citizens, between eighteen and forty-five years of age, fit for the military service, constitute the militia. The organized militia is that part of this body which is enlisted, equipped, and organized as the military arm of the respective states and undergoes training as such. It participates annually in an appropriation which is distributed by the general government under certain conditions. The unorganized remainder of these able-bodied men is the reserve militia. It is the organized militia, with which the officers of the respective states are directly, and those of the army may be indirectly, concerned. These organizations resemble military clubs, membership in many of which is acquired through community of taste rather than by physical examination, and proficiency in whose operations follows the stimulus of emulation more than the obligation of discipline. Their primary public function is the enforcement of the civil authority against mobs, or the protection of property on occasions of public disorder. Usually such duty is not protracted, nor does it involve prolonged physical exposure or absence from a convenient base. But in great emergencies the organized militia is liable to be called forth by the President, for a period not exceeding nine months, to assist in executing the laws of the United States or to form a line of national defence. For this reason these organizations are subsidized by the general

The militia

The organized militia

government and undergo some supervision by its officers. The diverse character of the militia's possible duties suggests a double standard of bodily fitness. For ordinary armory duty, street service, or that in camps of instruction, rigid physical examination would be superfluous and might be deterrent, and minors may safely be accepted because of the slight prospect of overstrain. Besides, young men are more tractable and have greater interest in these operations than those who are older. They learn the drill more easily and take more pride in excelling in it, and generally the men who reënlist are those who have earlier associations of this kind to maintain. Accordingly, militia recruits are apt to be youths who thus become "soldiers" to demonstrate their maturity and to indulge a natural desire for display by wearing uniform. Therefore, in order not to make enlistment too difficult, the physical examination frequently is superficial, chiefly designed to exclude obviously disqualifying defects. In some states the judgment of the individual examiner, and not a fixed standard, determines eligibility; and this is probably sufficient if the examiner is familiar with the duty to be required and is interested in keeping the command efficient. With youths who have not attained their development and to whom these exercises are an avocation and not a vocation, it would seem unreasonable to insist upon the standard weight and certain other excellences which a vigorous soldier should possess. It would be still more unreasonable to reduce the regular standard in order to include the militia. It is even possible that for minors in the state service a diminished chest capacity might be accepted. As long as the command is responsible merely to the state (as distinguished from the United States) it would appear judicious to establish a rather low minimum standard for that service, rigidly to require that minimum to be attained, and to note in the descriptive book the deficiencies of those unfit for prolonged field service. Those in the lower grade may gradually develop so as to reach the higher, as

Physical fitness

State standards

determined by annual reëxaminations, until the regular standard is reached and the record amended accordingly. There is no recognized provision for such action, but state regulation might authorize it when the embarrassment of attempting to put in the field ranks that must prove inadequate would be avoided. Some states, however, constantly maintain a high physical standard.

Militia in active service

But the President may call the organized militia, as such, into active service as part of the United States forces. As their organization is similar to that of the army, in theory this provides for mustering-in such commands without dislocating their own economy or disturbing that of the permanent establishment. The only condition which the law makes in thus accepting the militia is the vital proviso that the officers and men shall individually " be found fit for military service." This implies an adequate physical examination at the time of the muster-in, and upon that examination will depend much of the efficacy of the transferred forces. If it is inadequate, the rolls may be encumbered with mere names and the ranks will be weak from the absent sick. When therefore the organized militia are to be mustered-in, their physical vigor should be assured. This is the more important because at the best such service will be short, with little time to waste over defectives or to develop the immature.

Volunteers and conscripts

Hopes of recruits

Volunteers, men who in time of war pass into the military service for such limited periods as the law may define (usually two years, unless peace is declared sooner), are to be examined as regulars would be. In time of great public peril conscription may be enforced, when the conscripts, or the substitutes they may present, also are to be vigorously inspected with a bias toward acceptance. A fundamental distinction, which divides war-recruits into two classes, is always to be remembered. One class desires acceptance, one hopes for rejection. Citizens who do ordinary militia duty cheerfully and efficiently and who are perfectly fit for the field, may fear that nine months' active service will be detrimental or disastrous to their private interests, and may be tempted to exhibit blemishes hitherto unsuspected by their associates, with the suggestion that these would become disabilities under strain. The scrutiny must be just and the men who are fit are to be held to that contract with the state which implies this possibility of active duty. Others, not realizing what war means, in their anxiety to engage in it seek to conceal weaknesses which presently may disqualify. The exception to critical scrutiny of the militia is the rare but possible emergency when every man who can bear arms, if only for a time, must be hurried into the first line for immediate defence. When, as sometimes happens, militia regiments offer themselves collectively as regiments of volunteers, the physical examination should be critical, for the enthusiasm of contagion stimulates the applicants to appear at their best. Such regiments differ greatly in their physical efficiency, not only in different states but sometimes within the same state. Roughly speaking it requires three regiments of the organized militia to form one efficient regiment of volunteers; although as the physical selection of the state troops increases in rigor, this disparity will decrease.

Scrutiny

Its exception

Regiments volunteering

Notwithstanding that whenever enlistments are voluntary the rule is to reject when in doubt, when conscription is enforced this precept is directly reversed. Then the Government should have the benefit of the doubt, for the conscript will magnify every physical irregularity in his effort to avoid service. Besides, conscription implies a national emergency and need for a very large army; so that under a somewhat reduced standard a moderate percentage of tolerable, not unhealthy, men may be utilized in necessary but inconspicuous places. In justice to both the man and the public every deviation from the type is to be carefully entered in the soldier's description.

Conscription

V

MILITARY AGE

Age limits

Minors

Immature recruits

The legal minimum age for recruits is eighteen years and the maximum in peace is thirty-five. There is no maximum limit for subsequent enlistments. In war the maximum age for first enlistments is liable to be raised according to the exigency. The age limits of the militia are eighteen and forty-five years, but in the Civil War men were drafted only between twenty and forty-five. The authority to enlist a minor with his parents' consent, and this should be construed also to govern the muster-in of a minor militiaman, is subject to the important proviso that he is in all respects the equal of a man of twenty-one. Here recruiting officers are very liable to be misled, for it rarely happens that such a lad responds to the test of the field. Notwithstanding some youths of eighteen or nineteen have the physical figure of others two or three years older, their endurance cannot be determined by the measuring-tape or the balance. It is upon physique plus endurance that corporeal efficiency rests. In any particular instance the probability is against the minor being an exception who has prematurely attained adult vigor; and all military experience supports this physiological theory in objecting to minors for active service. The record of immature recruits is uniformly that of inefficiency and disease. Thus Napoleon after Leipsic (1813) demanded "grown men; boys serve only to fill the hospitals and encumber the roadside." In the Crimea (1854–5) Lord Raglan responded to the notice that two thousand recruits awaited his call, that "those last sent were so young and unformed that they fell victims to disease and were swept away like flies, so that he preferred to wait" rather than to have lads shipped to him as soldiers. Lord Hardinge writes of the same campaign that "although no men were sent under nineteen years of age, yet when sent out it was found that instead of being composed of bone and muscle they were almost gristle." Falsification of age is very common where minors may legally be enlisted. In Egypt, in 1798, the 68th British from Bombay was composed chiefly of boys. They lost nearly half their number from fever which broke out on their passage and they continued so sickly that they were reëmbarked and sent back. But the 61st, over nine hundred strong, nearly all old soldiers, who were sixteen weeks aboard ship, landed with only one man sick. We do not know the condition of the respective transports and the supervision the men received, but the element of age must have been an important, if not a controlling, factor. In the Peninsular War (1805–14) three hundred men seasoned and matured by five years' service were reckoned more effective than a thousand lads received as recruits. Our own medical officers in Mexico (1847) constantly reported that the inferior physique and especially the youth of the recruits materially swelled the lists of the sick and the dead. In General Roberts's march from Kabul to Kandahar (1880) "it was the young soldiers who succumbed to its fatigues, while the old soldiers became hardier and stronger every day." The Franco-German experience (1871) coincided with the earlier records. There are no authentic statistics that show the relative influence of age upon disability in the field during the Civil War, but all officers who served with troops then will agree in the general statement that the very young men were those who, as a rule, first broke down under exposure and hardship, as would naturally be expected. Even in peace the official reports show that the sick-rate of those under twenty-five greatly exceeds the mean for the whole army. In discussing the defectives in the Philippines during and after the insurrection of 1899–1900, Birmingham ranks immaturity as foremost among the agencies of depression, and says: "The number of undeveloped boys, ranging in age from 17 to 21, met with in the hospitals, whose only chance for life lay in building up their strength sufficiently to admit their being put on the first transport sailing for home, was simply deplorable." Personal observation entirely agrees with this. A private letter from a medical officer of experience reports: "A large majority of the men (or boys) invalided home from the Philippines were in their first or second year of service," which implies that the disability was primarily due to immaturity. As Marshall has explained, partly from experience and partly in prophecy, "This general assent shows how wrong it is to expect any great and long-continued exercise of force from lads as young as 18 or 20, and the inevitable consequences of taxing them beyond their strength." Hence it is the recruiting officer's duty to accept after critical examination only those who will probably become vigorous and active soldiers, for "nothing is so expensive as an unhealthy military force" (Farr), and "it is more important that a soldier should be strong than that he should be tall" (Vegetius). On the other hand, young men are much more easily trained and moulded, both in body and mind, than those who are older, and this is particularly true for the mounted service. When properly led, young men will fight as well and sometimes with more dash, as far as mere physical courage goes, than their seniors. But as under our military system great bodies of troops are only raised for the emergency of sudden war, large reserves of young soldiers, in training for several years for such an emergency, are not possible, and therefore immature recruits must be rejected. Moreover, older men have better judgment and greater endurance, and hence are more to be depended upon after they have acquired discipline. The most efficient field armies have always maintained their minimum age at twenty-two years, and it is more truly economical to reject a few exceptional youths who might

Advantage of youth

No reserves

Practical minimum

withstand campaigning than to risk accepting plausible enthusiasts who probably would be prostrated. The enlistment, at a lower rate of pay, of battalions of military apprentices between the age of 18 and 21, as once proposed for the army and as is successfully done in the navy, who should be trained and kept occupied with practical but not exhausting work at home, would provide a reserve from which, in time of peace, the ranks of the line could be filled with excellent soldiers and the minors now unwisely enlisted would be completely replaced. But no such scheme would be available in war. While immature men should not be accepted for service, neither are too old men good recruits. The regulation limit in peace of 35 is the extreme under ordinary conditions (and few learn efficient horsemanship after 30), although in war recruits who are physically sound may legally be accepted up to 45. But as they approach 30, common laborers are liable to become stiffened in body and dulled in mind and to acquire a rigidity difficult to overcome. For instance, in the Spanish War miners from the anthracite fields of Pennsylvania, although stalwart in body and accustomed to severe labor, proved as a class unadaptable and unacceptable recruits. Many such men have infirmities which do not materially interfere with their daily work, but which would unfit them for bearing arms. As a rule, few men approaching middle age, who enlist for the first time, accommodate themselves without distress, if at all, to the strain of the field.

Military apprentices

Maximum age

Unfitness from age and labor

VI

STATURE, WEIGHT, AND VITAL CAPACITY

Stature

In the popular view and in that of some officers, the typical soldier is tall. But existing orders practically and properly exclude very tall men by the required relation between weight and height. Exceedingly tall men, in whose favor an exception may be authorized by the War Department, serve only an ornamental purpose as drum-majors. Six feet is practically the maximum permissible height, and the best all-around soldiers in the ranks are between sixty-six and seventy inches in stature. Even were there no regulation, tall young men would be objectionable, because their height is often acquired without a correspondence in bulk and at the expense of vigor in the heart and lungs. A soldier is a machine of two parts: legs and arms, offensive; chest and abdomen, vital. Within the chest and abdomen is generated the power that makes the limbs formidable, so that an ill-proportioned tall man is undesirable as a soldier. One who is tall by virtue of his legs alone will become tired the sooner, and hence will march poorly. This is partly because his muscles are relatively smaller and the levers they operate, the bones, are longer than those in a shorter man, and partly because he almost certainly has a comparatively smaller chest and abdomen in which probably less vital force is produced. The relative capacity of the chest, as explained later, is the main index of the potential energy of the individual. It can hardly be repeated too frequently that physical vigor is the first essential of a combatant force. It is an axiom as old as the Romans that the strongest army is the best army, and under modern conditions the test of strength is marching. Certainly the

Extremities and great cavities

troops that march the best are the most valuable, and on them the generals must depend. It was the marching ability of Ord's infantry that made Appomattox possible.

Minimum height

There are three required physical qualifications for every recruit which are fixed by regulation rather than by law, and thus may be modified at any time at the discretion of the War Department. These are determined mechanically and are height, weight, and chest measurement, properly known as vital capacity. Under existing orders the minimum height for all arms except the mountain batteries is sixty-four inches. For the mountain batteries it is sixty-eight inches. It is permissible to enlist by special authority tailors, bandsmen, teachers, and other skilled men if not more than a quarter of an inch below the minimum. Although this limit may be changed in either direction at any time by regulation, experience has shown that sixty-two inches is practically the lowest limit for even tolerable efficiency in American soldiers; and when in emergency men of less than five feet have been accepted, as a class they have speedily broken down from sheer lack of physical strength. But men not more than sixty inches in height are frequently found in foreign armies and appear perfectly acceptable. A reasonable explanation of this discrepancy is, that any material curtailment of height in the individual below the average of that of the population, implies serious lack of development. In a country where the adult male is usually sixty or sixty-two inches tall, a man of equal stature is presumably of normal vigor; but where the average male is sixty-six or more inches, such a deficiency presumes both insufficient vitality and inadequate strength. Further, the equipment and the standard of exertion for an army whose minimum height is sixty-four inches and whose average height is considerably greater, are based on standards which much smaller men would fail to reach.

The maximum height for the cavalry and the field artillery (except the mountain batteries) is seventy inches. For

Maximum height

Weight and height

Modifications in weight

the mountain batteries it is seventy-two inches. For the cavalry and the field artillery an excess of a fraction of an inch in height is permissible in desirable men. For all other arms there is no fixed maximum height, which is practically regulated by the weight. There is a physiological relation between weight and height in young manhood to which the recruit should very nearly conform. But there may be natural moderate deviations from this standard which do not imply unfitness. The rule is: Two pounds in weight for every inch in height, and five additional pounds for every inch above sixty-seven. Therefore, to determine the normal weight, the height being known: multiply the whole height in inches by 2; multiply the inches above sixty-seven by 5; add the products. Thus, to find the normal weight of a man of five feet, ten inches: 5 ft. 10 in. = 70 in.; $70 \times 2 = 140$; 5 ft. 7 in. = 67 in.; $70 - 67 = 3$; $3 \times 5 = 15$; $140 + 15 = 155$ lbs., the normal weight. To determine the normal height of a man weighing 170 lbs.: $67 \times 2 = 134$; $170 - 134 = 36$; $36 \div 7 = 5+$; $67 + 5+ = 72$ in. or a trifle over six feet. The weight of infantry, coast artillery, and engineers must not exceed 190 lbs. Therefore, as $67 \times 2 = 134$; $190 - 134 = 56$; $56 \div 7 = 8$; $67 + 8 = 75$ in., so 6 ft. 3 in. would be the maximum height. Material deviations from the standard weight are allowed in each direction where the applicant is active, has firm muscles, and is manifestly vigorous. These deviations range from eight pounds below that stated for the minimum height to twenty pounds below that given for the man of seventy or more inches. On the other hand, unless the applicant is really obese, a marked disproportion of weight *over* height does not demand rejection, although it is undesirable in the mounted services. Indeed it is better that muscular men should be over than under weight. The maximum weight for cavalry and field artillery is 165 pounds subject to the permissible variation just noted. Weight within purely physiological limits is subject to much variation, depending upon the man's age and mode of life; but a marked deficiency in weight should be looked upon with suspicion, for fear of wasting disease or of insufficient strength. Under all circumstances there must be clear evidence of muscular vigor. A considerable change in weight may follow enlistment. Imperfectly nourished men are apt to gain, especially in garrison, by the regular and sufficient rations and stated open-air exercise; but some who go at once into the field will lose weight, because the new food may not be as acceptable as that supplied at home, it may be insufficient from imperfect cooking, and the demands of unusual exercise and of exposure to cold may draw upon the physical reserve.

Weight after enlistment

Chest measurement or vital capacity

Chest mobility

The third, and a very important, physical requirement is chest measurement, technically vital capacity. ("Chest measurement," as ordinarily used by physiologists, signifies the *mean* of the chest circumferences at forced inspiration and forced expiration.) As used officially, chest measurement is the circumference of the chest at the point of the shoulder blades after forced expiration. Chest mobility is the difference between the extremes of forced expiration and forced inspiration, and strictly speaking chest mobility and chest measurement taken together are the factors which determine vital capacity and indicate the breathing power of the recruit. As a man's vigor and endurance largely depend upon the quantity of air he inspires, which really means the amount of blood that he can cleanse physiologically and keep supplied with fresh oxygen, it is literally vital. Vital capacity, then, is the measure of the air that can be taken into the chest by forcible inspiration. It is usually expressed in the terms of its equivalent, that is, by the amount forcibly expired after forcible inspiration. The expired air is the more easily determined. This represents the supply of air upon which a person may depend in an emergency and not merely that which he ordinarily consumes, and it takes no account of the proportion which remains permanently in the lungs, the residual air. The capacity of the lungs increases with age to the thirtieth year (after which it slowly decreases), and bears a close although not quite uniform relation to height. Thus a recruit five feet, four inches tall should have a vital capacity of 198 cubic inches. This appears to decrease by about six cubic inches for each inch of height to five feet, and to increase approximately by eight cubic inches for every inch of height to six feet. Hence a man five feet tall should forcibly inspire 174 cubic inches, and one of six feet 262 cubic inches. Rules have been formulated to determine the standard capacity through the physiological relation of the circumference of the chest and its mobility to the height. The relation of chest capacity to stature should be: Between sixty-four and sixty-seven inches in height, the mean of the chest circumference should be thirty-three inches, or a trifle above one half the height, with a mobility of two inches. *The minimum at expiration is thirty-two inches.* Above sixty-four inches the measurement gradually increases until at six feet it is nearly thirty-six inches, or almost half the height, with a mobility gradually increased to three inches. Formerly the physiological standard and the official rules were in substantial accord, but for several years the regulation has established a somewhat lower standard and has also authorized the acceptance of a recruit whose chest circumference at expiration is two inches below that standard "when the applicant is active, has firm muscles, and is evidently vigorous and healthy." But no recruit should be accepted who could not thus be described, and officers are particularly warned against taking advantage of this unusually open door. The relations between height, weight, chest capacity, and mobility, according to the old and the present standards, are shown in this table.

Capacity and height

Circumference and mobility

Reduction of standard

(GREENLEAF, MODIFIED.)

Height.	Weight.	Chest measurement (at expiration).		Chest mobility.
		Old.	New.	
Inches.	Pounds.	Inches.	Inches.	Inches.
64	128	32½	32	2
65	130	33	32	2
66	132	33½	32½	2
67	134	34	33	2
68	141	34	33¼	2½
69	148	34½	33½	2½
70	155	35	34	2½
71	162	35¼	34¼	2½
72	169	35¾	34¾	3
73	176	36¼	35¼	3

To the officer chiefly concerned with men as they stand in the ranks, the foregoing details may be wearisome and seem superfluous. The earnest leader should not find them so, for they are not abstruse and they simply mark the lines within which to create an efficient army.

VII

GROWTH AND DEVELOPMENT

Growth and development

Before discussing the mode of selecting a recruit and the reasons involved, some elementary points in practical physiology must be considered. Because a man may have acquired his growth, it by no means follows that he is fully developed; for while growth "is the gradual increase to full size by the addition of matter," development "is the advancement of an organized being from one stage to another toward a more complete state." Physical maturity, that is, the entire development of the body, is not attained until nearly the twenty-fifth year, for which reason a man much less than twenty-two, and especially one not yet twenty, is very liable to fail under the tests of military life.

Skeleton

The skeleton is the bony framework designed to enclose, support and defend the important organs of life and to provide for locomotion. The separate bones arise from independent centres and they coalesce so slowly that some of them are not consolidated until the twenty-fifth year. Hence in the young the bones are not as fit for severe strain as in those older. This is painfully evident when the sacrum and hip-bones, which form the buttress and arches of the pelvis and are not consolidated before the age of twenty-five, are distorted by the habitual carriage of weights upon them in youth. Of course an applicant with a distorted pelvis would not be accepted, and the instance of such distortion is used merely to illustrate the combination of strain and immaturity. It is upon these associated bones that much of a soldier's burden-bearing may rest, because after consolidation they are best adapted to withstand such stress. But that neither invites nor encourages premature strain.

Relations of bones and muscles

Recruiting, and all other, officers should also remember the physiological relation which the bones and the muscles at large bear to each other in their growth; for the muscles, that is the flesh, whose contractions cause the voluntary physical movements, are attached by their extremities and sometimes along a part of their length to the bones. Obviously, large and powerful muscles require proportionately large and powerful bones, with well-developed ridges and prominences upon them for attachment and efficient work; and both bones and muscles must be relatively large in men of whom hard labor, such as active warfare, is required. Further, under favorable conditions development increases for a number of years while growth has almost ceased, and the bones become thicker, the joints stronger, and the shoulders broader from the twentieth to the twenty-fifth year. The maximum height is barely attained at the twenty-fifth, and the muscles gradually develop in size and strength to the thirtieth year. The further increase in size that occurs after full maturity is generally the laying on of fat, which sustains no immediate relation to health or vigor.

Development

Pressure upon bones

While yet in the stage of development, growing bones may be bent unnaturally, as conspicuously illustrated in bandy legs, where children have been allowed to bear their weight upon them prematurely. Distortion may also follow lateral pressure on the long bones of the chest walls, the ribs, to the hurt of the young soldier. This may also supervene upon the mere carriage of weights. Pressure before or behind, which limits the natural elasticity of the ribs, interferes with the full dilation of the lungs and occasionally disturbs the action of the heart; for, owing to their elasticity, the bony walls may be materially compressed and even such apparently trifling agents as the canteen and haversack straps may restrict their free expansion. It is scarcely worth while to have a possible mobility of two or two and a half inches when un-

Constriction of chest walls

restricted, if the bones are not vigorous enough to withstand that form of intermittent necessary pressure. The more immature the recruit, the greater this evil by the "set" which the walls may receive. It must be admitted, however, that independently of any distortion, pressure upon the chest of even a relatively seasoned soldier may affect the contained organs by limiting the rhythmical expansion of the bony cage; and in the recruit this might be conspicuous as well as highly injurious.

Because it is indispensable that they shall be sound and be free in their action, it is more important to understand the development and to arrange for the care of the heart and the lungs than to study the consolidation of the skeleton. The lungs practically are sheets of delicate membrane upon both sides of which run blood vessels (capillaries) still more delicate. This supporting membrane is so intricately folded as to appear a spongy mass, whose ultimate interstices are vesicles not discernible by the naked eye. On both sides of these walls the air bathes the capillaries and gives to the blood the vital oxygen, while simultaneously it receives from it watery vapor and the gases of organic dissolution, chiefly CO_2. This interchange takes place directly through the capillary walls by that physiological leakage known as osmosis. When the vesicles expand, more air comes into contact with the capillaries; their contraction, or their collapse as sometimes occurs, not only diminishes the quantity of air which may be present but sometimes affords a special seat or nidus for the deposit and growth of the tubercle bacillus, which causes consumption.

Lungs

Lungs in overtraining

Overtraining occasionally leads to undue expansion of some of the vesicles and to overstretching and impairment of their elasticity (emphysema, as in the heaves of horses). More commonly the abrupt cessation of severe training leads to collapse of the walls of the vesicles and hence to an opportunity for tuberculosis. But the most common fault in caring for the lungs is insufficient expansion of the chest through tight clothing and the pressure of straps, so that Aitken is quite justified in saying that "Next to the inspiration of bad air, the imperfect or continuously obstructed expansion of the chest tends more than any cause we know of to bring about diseases of the heart and lungs." This must constantly be remembered in the effort to adjust the pack, some sort of which it is imperative for the soldier to carry in the field.

Compression of chest

Heart

Heart-growth at puberty

The heart, which drives the blood throughout the body, is not completely grown until the twenty-fifth year. Unusual continued exertion, of which athletic training is a type, generally develops a temporary hypertrophy, or overgrowth, of the heart which may or may not become permanent according to circumstances. The heart is particularly sensitive because of the peculiarities of its growth. Its greatest proportionate increase is at the accession of puberty, when it nearly doubles its size. Now if that period occupies five years the heart-increase each year is one-fifth; but if it occurs in one year or two, the growth is so much more rapid that the heart may not acquire strength in proportion to its size. Sudden increase in the volume of any muscle — and the heart is merely a complicated muscle — implies weakness of structure until vigor comes with time. Young fibres have not the elasticity, tone and stoutness of those more mature, so that a heart which grows in one year three times as much as in the preceding year is almost necessarily weak. Hence a rapidly grown youth has a rapidly grown and comparatively weak heart, and until it has become mature such a recruit would not be acceptable for continuous labor. The most extreme disproportion of growth occurs at puberty; but there is a continual increase in size for years, so that the greatest amount of growth is from the eighteenth to the twenty-fifth year. This gives point to what has already been said of the undesirability of immature youth as soldiers, and it should teach

Heart-strain

Drill as affecting the heart

Caution in drill

the lesson that no physical dependence can be placed on very young men for continuous heavy work, particularly under military conditions and when there is any restraint over the expansion of the chest. "The greatest strain is thrown on the heart throughout adolescence to adult age, and a very constant group of symptoms indicates the cardiac failure that must be looked for in overworked recruits" (Aitken). This condition, with the other weaknesses of immaturity, accounts for the strewing of the roadside with young soldiers as Napoleon complained, and for the choking of field hospitals and sick-transports to this day when such lads are drawn into the service. It is the heart-strain from excessive fatigue in those who have grown rapidly and hence have deficient reserve energy that leads to heart-failure under unwonted exertion. It is this liability in the young soldier, whether he has grown rapidly or not, that is one of the most serious objections to raw levies which so often are youthful. Heart-strain in various degrees usually precedes positive breakdown and is caused by overtaxing the strength, commonly in drill or in the heavy marches of actual war. The purpose of military drill is to familiarize the soldier with certain movements that secure his greater efficiency, especially in coöperation with others, and to develop his physical endurance. To that end it should be gradual. A young recruit cannot keep pace with a full-grown and completely trained man in the ranks, mainly, not on account of the fatigue of his arms or legs but, because his heart and blood vessels are neither fully developed nor especially accustomed to such work. Failure usually arises from attempting too much at the outset. With excessive work at the beginning, or with its sudden increase as in forced marches, these youths rapidly break down. Drill must begin within the recruit's power of endurance, and the young soldier, usually persisting too long from pride, should be encouraged to fall out of ranks promptly at the first serious distress.

"The throb of the heart and the swell of the arteries and veins must be allowed to subside and settle down completely, so that the lungs may resume their peaceful action of easy breathing, before any further drill exertion is attempted" (Aitken). The company officer must bear this in mind and watch his young men in the ranks. If the man's breathing does not gradually improve, or if the man's weight continues to decline, he should without further delay be referred to the medical officer for examination. The company officer should not wait for the man to report sick; he should take the initiative himself, and in this way much valuable time often may be saved. In such cases treatment cannot be hurried. To take a young soldier in such a state into the hospital for a week or two, only gives temporary ease. No medicine is a substitute for strength, and it may require six months for the immature heart to recover from such a strain. Premature duty will cause the same symptoms to recur again and again, until the condition is outgrown by normal development or the heart is permanently damaged. The lesson is, not to accept minors if it can be avoided.

Rest in heartstrain

VIII

SELECTION OF RECRUITS

In peace under existing regulations applicants for enlistment are selected at recruiting stations by officers of the line and then are sent to recruiting depots, or recruiting depot posts, as the case may be, where they are critically examined by officers of the medical corps who enlist those whom they accept. After a certain amount of training at the place of enlistment, recruits are assigned to and join their respective regiments. Probably in war most regular recruits will be immediately assigned to regiments and volunteers will be accepted after scrutiny by line and medical officers, subject to re-inspection on the occasion of muster-in. Notwithstanding line officers do not, as formerly, actually enlist recruits who have been passed by the medical officers, it now rests with them to select the candidates who shall be subject to the final tests. They have the important responsibility of rejecting outright those applicants whom they believe unfit, and the further obligation to send forward only those who in their judgment are fit for military service. There is a double duty, — that of not rejecting qualified men and that of not incurring unnecessary expense in sending to the enlisting depots unacceptable applicants. It is therefore important for the recruiting officers to make these preliminary selections with the same care as though they were to be final. When he exercises his judgment in establishing a presumption in favor of an applicant as one who would probably become a strong and active soldier or in rejecting him outright, the officer has in the recruiting regulations a safe and explicit guide. Sometimes there is temptation to disregard their particulars

Recruiting stations and depots

Selection by line officers

under the feeling that, apart from obscure disease, any officer accustomed to soldiers can recognize an acceptable recruit at sight. Therefore, omitting morbid conditions or physiological irregularities discernible only by special knowledge, this advice is prepared for the recruiting, not the enlisting, officers.

Preliminary survey

Inaptitude

Conscripts

A recruiting officer should not select a man merely because his appearance is prepossessing, nor accept as a final affirmative the bare fact that no disease is obvious. Many a first-class insurance risk would be worthless as a soldier. A comprehensive and careful survey of the applicant should first be made, after he has been stripped of clothing and washed clean. It is impossible to judge of the physique (except the stature) of any man while he is clothed. All lank, slight, puny men with contracted figure, men technically known as of "poor physique," should be set aside, for there is no class that furnishes so large a proportion to the hospital and the guard-house as this. "Another class, having neither apparent disease nor well-characterized physical or moral defect, is equally objectionable; there is a something about them [which may well be termed want of aptitude] which satisfies an expert that they will make either indifferent or bad soldiers" (Greenleaf). In all cases of doubt, reject. It is sheer waste for the government to take care of incompetents. The army is neither a reformatory nor an almshouse. The exception to rejection for want of aptitude is the conscript. Men who fail to volunteer in war have little military zeal, but under the stress of conscription they may safely be intrusted to the discipline of the camp.

A summary of the physical qualifications desirable in a soldier is this: "A tolerably just proportion between the different parts of the trunk and members, a well-shaped head, thick hair, a countenance expressive of health, with a lively eye, skin not too white, lips red, teeth white and in good condition, voice strong, skin firm, chest well formed, belly lank, organs of generation well developed, limbs muscular, feet arched and of moderate length, hands large." **Desirable qualities** The more nearly the chest is barrel-shaped the better. When a man is found who has these qualities or an approximation to them, his formal examination should begin. **Examination** The first steps are to take his weight, his stature, and his vital capacity. With accurate scales the weight is a simple matter; but it is to be taken, not estimated. **Weight** Most young men while standing are able temporarily to alter their height by a considerable fraction of an inch, in order to avoid rejection or acceptance as the case may be. **Stature** Such a one, if suspected of deception, should be laid flat on the back on a table or the floor, when he can neither increase nor diminish his true length, and the distance between fixed points at his head and his heels be measured by a rod or an inextensible line. That determines his exact stature. **Vital capacity** Having found that weight and height are within acceptable limits, the more delicate determination of vital capacity through chest measurement and chest mobility succeeds. Unless these three points are satisfactorily established, it is useless to proceed. No length of limb, muscular development, nor apparent intelligence can replace air-space for the purposes of the field. **Chest measurement** The official direction is to apply at forced expiration "a tape at the point of the shoulder blade, when it will generally fall below the nipple." This is liable to describe an oblique rather than a horizontal plane, so in actual practice the tape is usually applied just below the nipple where a horizontal section would cut rather above the extremity of the shoulder blade. The object is to find the size of a minimum cross section at this particular point, and the tape must be used while the arms hang naturally. **Chest mobility** To determine chest mobility, the circumference of the chest is taken at the same point at forced expiration and forced inspiration with the arms hanging naturally and by preference without removing the tape. The difference between the two findings is the mobility. Certain precautions are necessary in even these simple acts. The applicant must stand erect with the chest muscles perfectly relaxed, excepting as required for breathing. Some men because directed to do so fail to inhale or exhale at the word beyond very narrow limits, and patience must be used to overcome their nervousness. The chest may be efficiently emptied by counting aloud without renewing the breath. Several repetitions usually result in regular and deep breathing. Recruits sometimes contract the chest or attempt its expansion by violent muscular efforts or by bending forward or backward. All that is irregular and defeats the true object, which is to obtain the capacity of the chest, not to measure muscular contractions. Of the two factors, the mobility, when properly taken, is the more important, because it represents the possible increase on demand of the volume of air. The circumference is better taken first at expiration, for the tape may slip down after the limit of inspiration has been measured, which would make the boundary of the described plane oblique. Where there is much fat or a very considerable muscular development of the walls, the circumference at the surface may not bear a true relation to that of the chest-cavity, but the mobility will remain a fair index.

Precautions

Besides the capacity for abundant air, the integrity of the lungs and heart, upon which the man's "wind" depends, is essential. This may be roughly estimated by requiring the candidate to run briskly about the room and observing whether he breathes through the mouth, and whether the breathing is materially quickened during such exercise. Either condition would condemn, or at least make acceptance doubtful. After or before this or other active exercise, should the pulse at the wrist drop a beat at regular or irregular intervals, reject.

Condition of chest-organs

The senses of hearing and sight are next to be tested. Each ear must clearly distinguish ordinary conversation at a distance of fifty feet. This is best determined by causing the remarks to be repeated; not by having questions **Hearing** answered, for sometimes they may be guessed. Unilateral deafness, which is not uncommon and is disqualifying, is only surely detected when an assistant, not the recruit, completely closes each ear in succession by pressure. Sight is tried by test-cards, each eye in turn being **Sight** covered by cardboard, not by the hand. Because rifle-shooting requires the use of only one eye, binocular equivalence in vision is not demanded. If there is no organic disease in either eye, a recruit with acuity equal to $\frac{20}{40}$ in the better eye and $\frac{20}{100}$ in the poorer may be accepted for the line, the engineers and the signal corps. For other enlisted men a minimum of $\frac{20}{70}$ in each eye correctible with lenses to $\frac{20}{40}$ is sufficient. That is, recruits for the line may be accepted when the better eye is unable to read all the letters on the $\frac{20}{40}$ line, provided they may read some of those on the $\frac{20}{30}$ line and there is no organic disease in either eye. The explanation is that rifle-shooting requires only monocular vision, and a perfectly defined image of the target, although desirable, is not essential for fair marksmanship; and it has been determined experimentally that when the soldier learns to focus the sights of his rifle an acuteness of one-half the normal is consistent with good shooting. The same degree of acuteness is sufficient for the perception of distant objects. All variation from the normal must be carefully noted on the papers. Every recruit is to be tested for **Color-blindness** color-blindness, and the finding noted; but color-blindness disqualifies only for the signal corps. "The development of the head and the symmetry of its proportion should be as carefully insisted upon as **Skull** with organs and regions" (Crawford). The skull must be carefully examined with the fingers, and rejection should follow any depression not certainly natural, any serious scar, or any sensitive spot; for men with such blemishes invariably break down under exposure to heat and frequently under great fatigue. Sound opposing teeth to chew well the difficult food of the field are necessary. Existing orders allow the acceptance of men otherwise qualified who have four serviceable double teeth, two above and two below, in such opposition as will allow mastication. That appears to be a physiological mistake. It would seem that two good grinders opposite each other on each side should be the minimum. The moment one of the four teeth now regarded as sufficient becomes useless the man is handicapped, and two lost from the same jaw disqualify for further service. This recognized margin of safety is very narrow.* Unmasticated food leads to intestinal disease, and carious teeth, especially in early life, mark a feeble constitution easily broken down. All the joints should be strong and mobile, and special pains should be paid to the thumb and forefinger, because of their great importance in handling arms. Strength and mobility are indispensable in the thumb which, acting in opposition to the rest of the hand, is the characteristic distinction between man and the quadrumana. Its grasp renders possible making fire, the use of weapons, and the art of weaving, the antecedents of civilization (Whitehead). The soundness and mobility of all the limbs are to be determined by their exercise separately and together. This is especially important with the legs, each of which must do its full share of work. The number of hops with which each leg covers in succession a given distance should be silently noted, for should they materially disagree weakness or stiffness would be indicated. Prominent veins of the ankle, behind the knee, or on the thigh are cause for rejection when multiple and really large, but a few inconspicuous veins do not disqualify. The testicles

Teeth

Thumb

Vigor of the lower limbs

Varicose veins

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* Recent orders modify this to "at least six serviceable molar teeth, two above and two below on one side, and one above and one below on the other side, and so opposed as to serve the purpose of mastication."

are to be handled, and if either is sensitive or both have dwindled there is cause for rejection. But non-sensitive, **Testicles** undersized testicles should not disqualify a conscript. The dread of flat-footedness held by many recruiting officers leads to the occasional rejection of fair **Flat feet** men, but in point of fact it rarely is seen among American whites. In the disqualifying flat foot the inner ankle is very prominent and lower than usual; there is a hollow of greater or less extent below the outer ankle; the foot is not well arched, and is broader at the ankle than near the toes; the inner side is flat and occasionally convex, and the finger cannot be introduced beneath the sole when this rests on the ground; the weight of the body presses on the inner side of the sole, and the ordinary motions of the ankle are impaired. Bunions that are large or have been **Bunions and corns** recently inflamed incapacitate, for they will immediately disqualify when a tightly fitting shoe is worn or much walking is attempted. Corns on the sole are troublesome, and when under the base of the great toe unfit for active duty. A toe, usually the second, is sometimes stiffened at right angles so that the nail touches the ground. **Hammer-toe** This is known as "hammer-toe," or " walking on the nail." It disqualifies because, although a man may walk fairly well when the conditions are favorable, in the field sand will work under the nail and cause inflammation. Occasionally one toe is displaced so as permanently to override another. Both these conditions are due to wearing tight shoes while the foot is growing, and both unfit for marching. **Hidrosis** Fœtid perspiration of the feet is a disease that is intolerable in the squad-room. It is distinct from uncleanliness and no amount of washing will avert **Birthmarks** the odor, so that an applicant thus afflicted should be rejected, or, if enlisted inadvertently, should be discharged. Unsightly markings, congenital or acquired (excepting as due to wounds in service), disqualify because they may lead to rude and vexatious jests. The utmost care should be had to exclude men likely to be intemperate, for the intolerable nuisance that drunkards are within the service warrants the occasional risk of rejecting a sober man while refusing to accept those who constantly make trouble during peace and are not to be depended upon in war.

Intemperance

IX

GENERAL PHYSICAL ORGANIZATION AND CARE OF NEW ARMIES

Rural and urban recruits

Town recruits

When selection is possible, in raising troops for immediate active service town-bred men are preferable to those from the country. If war is not imminent and a year or two may be had for training, then country-bred men should be chosen. To city men whose lives have had artificial limitations and many of whom are accustomed to irregular hours, unwholesome meals, crowded and poorly ventilated lodgings, the open air and more regular military life are physical promotion. When there is added a vigorous but just control, their military education proceeds rapidly. They have survived, and therefore are immune to, the contagious diseases to which all whose exemption has not thus been secured are constantly liable; and their minds and bodies are alert and receptive toward the new ideas and the physical requirements of discipline and drill, although at first they may not be very docile. Town recruits are also apt to have had some training in the mechanical trades, valuable accomplishments in war. They must be more carefully scrutinized than rural recruits for the physical signs of vice.

Country recruits

To young men from the country whose mode of life has been uneventful, with abundant and regular meals, unbroken and sufficient sleep, and uniform toil in the open air, the irregular and sometimes indifferent meals in the field, the scanty shelter and the broken rest, the unusual nervous strain of new conditions and of peril, as often imaginary as actual, are exhausting; they find the habit of exact, unquestioning, and immediate action difficult to acquire;

and above all there is the certainty that they will contract such diseases as measles and mumps, frequently whooping-cough, and occasionally scarlet fever, all serious in the field, which there is reasonable assurance that the townsmen may have had once for all in childhood. This is strikingly shown in the contrast between the health of town and country companies when, as sometimes happens, the same regiment contains both. However, after a year's training and elimination in the field the somewhat seasoned remainder of the country recruits will usually exhibit greater ultimate endurance. With both classes, and especially with the country-bred, not only should minors be excluded as far as possible, but preference be given to men of really mature physique. A capital illustration of the practical value of this rule was observed in a Missouri regiment in camp at Chickamauga in 1898. It preserved excellent health in local conditions that were particularly unfavorable (for which it was not responsible) and amid much surrounding illness. The men, who were town-bred and far above the legal maturity, had been carefully selected by an intelligent officer of the National Guard who made a practical application of his study and experience.

Contrast within a regiment

Example of maturity

After muster-in all volunteers should be detained for a short time in camps of observation to weed out imperfect men inadvertently accepted. The exceptions are conscripts and men enlisted under excessive bounties, who should be allotted to active regiments in the field without delay. For physical as well as moral reasons the government should distribute such men among experienced troops for inspiration, instruction and restraint. Any actual infirmities overlooked at enlistment will soon develop without the encouragement of a special camp, while a certain proportion of minor ailments will be forgotten in the diversion of active war. Newly raised troops undergoing instruction and observation are better encamped out of their own state, certainly away from their immediate vicinage, to avoid

Recruit camps

commiseration on the one hand and laudation on the other, both of which are prejudicial to efficiency; and, as effectiveness is conditioned upon vigor, even at that date all whose real unsoundness may then be exposed should be discharged, and the civil origin of their preëxisting disabilities be clearly noted on their papers. Enormous camps of new troops, as sometimes organized, are objectionable because, among other reasons, of the facility with which diseases, especially those that depend upon the presence of other cases, are propagated.

Danger of great camps of recruits

The difficulty of administration increases directly as the size of the camp, and such an epidemic as measles, for example, once started will rapidly attack all who are susceptible. In like manner typhoid fever, difficult of limitation and always to be found somewhere in a recruit camp of any duration, will lay waste the whole if allowed headway.

Recruiting, although not strictly a subdivision of hygiene, is thus dwelt upon because the foundation of any military structure is its physical condition, and it is impossible to secure an efficient army unless the men are carefully selected. After enlistment, an equal duty rests upon company and other officers that these men are not impaired by their new surroundings.

X

SICKNESS AND VIOLENCE COMPARED

Very little sickness is spontaneous, and with an army of sound men there is no good reason why there should be much loss of duty from disease. When company and senior officers study for themselves the problems of ventilation, of food, of the healthfulness of camps, of water-supply, of the disposal of excreta, when they concern themselves with soldiers as physiological agents rather than as automata, the army will be prepared for the highest exhibition of sustained action. But hitherto sickness has ravaged armies and determined campaigns, so that the real measure of physical incapacity has been the amount of disease rather than the number of deaths. Morbidity, or the sick-rate, therefore is more effective in influencing operations than mortality or the death-rate, battle-losses excepted. This is because the sick are for the time as ineffective as the dead, and their care, especially the care of the seriously ill, is a greater drain upon the resources of the living than would be substitution for those killed in action. Further, the presence of the sick implies the existence of a continuing cause, whereas engagements are usually the consequence of election, to be accepted or avoided at pleasure. It matters very little what the particular cause of the unfitness may be at any one time, as long as so many men are then unfit for duty. The actual and the probable sick reports combined restrain a command by interfering with its mobility and weakening its fighting power. By the probable sick report is meant such a state of health or endurance that while the command may do a certain form of duty, say in garrison, it might not be able to take the field or to undergo

Morbidity

Probable sick report

peculiar hardships, or being in the field, it would be unable to overcome certain further obstacles of climate or contamination. Of course the probable sick report might be more favorable and encourage operations that the actual sick report would preclude, but that is not the usual prospect.

Mortality from illness and from violence

As would be supposed, in peace, notwithstanding sanitary conditions may be assumed to be at their best, casualties by violence are so few that disability from disease is very much in excess of that from injury. But it is in war that fatal sickness, quite independently of that which is recovered from or which leads to discharge without immediate loss of life, so far overbalances the mortality of battle. For instance: In Mexico (1846–7) among the United States regulars the deaths in the field from disease were nearly five to every one from wounds, and among the volunteers it was about seven to one. During the Rebellion (1861–5), of the Union white troops there died nearly two to one and of the colored troops nearly nine to one by disease over injury, besides the enormous number discharged for disability. The Santiago campaign (1898), successful without great loss in the direct collision, culminated in the virtual dissolution from disease of the invading corps as a further aggressive force. Harrington, consolidating the Cuban and Philippine campaigns for the year ending April 30, 1899, placed the deaths from disease at five and six-tenths (5.6) to one from traumatism. These figures have not been verified, but it is certainly the case that in the Philippines the number constantly sick was vastly greater than those off duty from wounds. That the German army in 1870–1 kept its mortality from disease below that from battle probably depended largely upon the shortness of the war, the rapid succession of severe engagements, the highly trained troops, and presumably upon its exact discipline being exerted for the care of the men as well as in other directions. In the Russo-Japanese war the mortality from disease among the Japanese as compared with that from wounds was as three to two, and Major Lynch, Med. Corps, U.S.A., who was present, expresses the opinion that, considering the duration of the hostilities and the country where they were carried on, the hygienic results of the Japanese were " decidedly superior to those of the Germans," by whom "previous to this the best figures were obtained " (*Mil. Obs.*, p. 185). He adds that, excluding beriberi " the Japanese could have shown results [with the diseases common to western armies] so good that they would have upset previous ideas on the subject of sanitation in war " (p. 186). It should further be remembered that the mortality from wounds not directly fatal was also greatly reduced. As a consequence of this diminution in the aggregate of battle fatalities the proportion of deaths from disease among the Japanese was, in comparison, reduced by that much; for had the consecutive battle mortality remained at the older rate the relative exemption from fatal disease as compared with other armies would have been raised still higher. Major Lynch attributes this happy condition to no special immunity of the Japanese soldiers from those or other diseases, but to their being sturdy men, inured to hardship at home, whose high strain of discipline assisted them in being guided by the sanitary instruction their officers imparted and to the zeal of the officers in thus caring for the men. Surely that should not be an impossible standard for Americans to attain.

XI

MILITARY CLOTHING: CHARACTERISTICS AND MATERIAL

As the non-essentials of dress are usually objectionable as well as valueless in war, the clothing that the soldier must **Object** wear should be simple and suited to his arduous work. The essential object of all clothing is the protection of the person from extremes of temperature, by conserving bodily heat in cold weather and preventing discomfort or harm from solar heat or that generated by exercise. A secondary object of military clothing is to foster proper professional pride in the soldier, to aid in determining his place in the army, and to render him inconspicuous to the **Distinctive markings** enemy. For facility of administration each arm of the service should have its distinctive dress, and the subdivisions of large commands may conveniently be identified by conventional badges assigned to the respective army corps. Examples of such corps badges would be the Maltese, the Greek, or the St. Andrew's cross, the trefoil, the diamond, the triangle, all cut from cloth and most satisfactorily attached to the hat. Those of the first division would be red; of the second, white; of the third, blue on a white ground following the order of our tricolor; and where there is a fourth division, orange or yellow. This simple device encourages the feeling of comradeship and is valuable for identification, and at the same time it is not discernible by the foe. Conspicuous marks having regimental significance, **Regimental symbols** such as newly raised and enthusiastic volunteers, or state troops called out for the time under the older methods, are tempted to adopt, should never be permitted. They are a sign of rawness and their ultimate effect is to draw fire. Less obtrusive distinctions, as regimental facings, are sometimes advocated in the interest of regimental *esprit*, and good results should follow their adoption by good troops. But a minor objection to their use is that of cost, and a serious one is the difficulty of supply in war when they are most desirable. The British suffered severely in the Crimea through the attempt to maintain distinctive regimental clothing, and their men were insufficiently clad until it was abandoned. Doubtless our state troops will long continue to wear showy dress uniforms for purposes of display, and these effect a useful end in appealing for recruits. But their fighting clothing, the undress, should be identical with that of the United States for security and especially for convenience of administration.

Color

Color has a greater military and physiological importance in clothing than its æsthetic significance, and soldiers' garments should be neutral in tint. The most serviceable colors, especially under exposure to long-range firearms, are the least showy, being shades of gray and drab, next to which is a light butternut dye. Their visibility marks the order in which colors attract observation, that is, the order in which they draw hostile fire, and the range runs red, white, black or dark blue, light blue, butternut, dust- and olive-gray, and drab, practical illustration of which is the every-day use of red and white for surveyors' flags or signals. Scarlet tells with great effect upon the wearer, and certain so-called zouave regiments have left upon the field killed who might have been spared in plainer dress. The old white cross-belts have often served as a shining mark for death, and the same has been occasionally true for the infantry shoulder-straps on the khaki coat, at one time required, glaring white objects between which to aim. Gray as a designation covers a considerable range, and at one end of the scale it differs but little from light blue. In large masses dust-gray, the true khaki hue, and olive-drab are most nearly invisible. This is particularly true for arid countries and among tree-trunks, for the contrast with the background is an element of distinctness which materially affects concealment or discovery. The ordinary stain of the soil also is less visible upon these neutral tints, so that they better preserve the appearance, if not the fact, of neatness in the execution of rough work. The color of the full-dress uniform, used only on occasions of ceremony for display and then for relatively short periods, has no particular hygienic significance except in the tropics, where the effect of the sun's rays requires it to approach as nearly as possible to white.

Heat and clothing

The heat of the body which may be modified by clothing is practically that generated by the body itself or that derived from the sun. The exception, which is unimportant, is the warmth from fires, or from other substances previously heated. Clothes by themselves do not create heat, as is clearly demonstrated by clothing an inanimate object and keeping it out of the sun's rays, when its temperature will remain that of the surrounding air. The color of clothing has no influence upon the retention or the waste of physiological heat, that generated by the body; but color does modify the heat received directly from the sun's rays, although it does not affect solar heat out of those rays. This influence of color is quite irrespective of texture, so that protection against direct solar heat depends entirely upon the color itself, the absorption being graduated by the shade of the fabric. White absorbs the least heat and is therefore the coolest; black the most, and is the warmest; and blue is next to black. A thin white tissue worn over a dark cloth coat has been found to reduce the superficial temperature in very hot sun's rays by 12.6° F. Besides the rays of heat and the visible rays of light, there are emitted by the sun other rays which accompany visible light and are known as the chemical rays. These are not recognized by the senses, but there is increasing reason to believe that when in excess they may act injuriously on the human system. The chemical rays are neutralized

Relation of color to heat and chemical rays

by the interposition of an orange barrier, as familiarly recognized in the photographer's dark room. They are equally intercepted by orange clothing, whether that is on the outside or is concealed nearer the skin. Reasons why light and heat should sometimes be modified will be given further on.

Odor

The absorption of animal odors by clothing depends partly upon the color and partly upon the texture of the articles worn. Black absorbs odors most readily, blue the next, white the least. Dark colors, therefore, should not be worn by those associated with the sick, and dark underclothing, instinctively avoided, would be unpleasant next the skin unless changed very frequently, as are stockings. The hygroscopic quality of the material also affects the absorption of odors.

Bodily temperature

The internal temperature of the body is 100° F., decreasing toward the surface until it is 98.4° near the skin. The act of living generates heat by the chemical changes taking place in the body. These vary a little according to diet, and always are greatly increased by physical exertion. For the bodily temperature to remain several degrees below the normal would result fatally, and any decided rise above the standard implies illness. That is, life cannot be maintained when the temperature is materially depressed for any length of time by artificial means; and the condition of being superheated is also morbid, so that a considerable unrelieved excess leads to death. We adjust our personal temperature by conserving it when the atmosphere is too cold and by radiation when it is too hot, the chief agency through which this is done being the clothing. We therefore speak of clothing as warm or cool, as it retains the heat of the body or allows it to escape, although intrinsically no clothing possesses the quality of warmth or coolness. Besides the natural tendency of all bodies to equalize their temperature through radiation, the evaporation of the perspiration which is induced by exercise sensibly reduces the

Regulation of temperature

Cooling by perspiration

heat which that exercise creates. But although it is reduced, the development of heat does not at once cease when exercise stops, and the perspiration continues flowing for a time. Hence continuous rapid evaporation, if unbalanced by the production of heat or unchecked by the absorption of the fluid in the clothing, may chill the body and is liable to be followed by sickness. On the other hand, if the clothing interferes with the natural radiation from the body, or with the vaporization of the perspiration, there will be an uncomfortable and sometimes a dangerous accumulation of heat.

It is to be remembered, then, that although clothing creates no heat it regulates that of the body according to its texture.

Heat conduction

Either being a poor conductor it prevents the body-heat from escaping, or the radiation through inadequate protection and especially the evaporation when wet reduces the temperature too rapidly for the maintenance of health. Hence the character of clothing upon which the conduction of heat depends is an important consideration whose neglect has led to disease and ultimately to death.

Materials

The common materials for military clothing are wool, cotton, and occasionally linen, with leather, india-rubber, canvas, and oiled cloth as auxiliary. Both cotton and linen conduct heat rapidly and hence are regarded as "cool" clothing.

Cotton and linen

They are therefore unsuited for the colder climates and especially for situations where the atmospheric changes are abrupt or extreme. Neither cotton nor linen absorbs water well. They readily become wet, but they do not take up the water. Hence they speedily become drenched by perspiration and its rapid evaporation proceeds practically unchecked. By themselves, therefore, both of these materials are unsuited for ordinary military clothing in any climate, and when exclusively used they are dangerous for men liable, as soldiers are, to violent exertion followed by sudden unguarded rest. The uncontrolled evaporation cools the body too promptly and leads to chilling from which illness may follow. Nevertheless when the temperature of the air in the shade approaches the normal heat of the body (100° F.) and that in the sun is much above it, the system becomes enervated and the clothing should not add to the embarrassment, as heavy wool, once the universal military dress, would do. On that account the fabric known as khaki is made in cotton as well as in wool (serge). The use of cotton, whether as khaki or as ordinary drill, presupposes as a sanitary measure, for reasons presently to be explained, a light woollen undershirt also. A special weave of linen for underwear is now on the market for which it is claimed that so much air is entangled in an open mesh as to make it a partial and a pleasant substitute for woollen; but on theoretical grounds this hardly seems safe. Linen is too costly for general issue, but cotton is cheap and very durable. Therefore in tropical climates olive-drab cotton khaki, guarded by mixed woollen underwear, is appropriate. But starched cotton and linen are nearly impermeable to the air until broken down by perspiration, and hence they are very hot.

Cotton khaki

Linen underwear

Wool conducts heat badly and absorbs water freely in two ways. The water permeates and distends the fibres of the wool (hygroscopic water) and it collects between the fibres (water of interposition). As compared with cotton or linen, wool absorbs hygroscopically at least double in proportion to its weight and quadruple in proportion to its surface. Dry woollen clothing condenses the vapor given out from the surface of the body as insensible perspiration, and much heat that had become latent when the fluid was vaporized is then released. This is one of the reasons why dry woollen clothing yields a sense of warmth. It also absorbs the perspiration that persists after excessive exercise has ceased, and thus prevents its evaporation and the consequently abrupt cooling of the body. And while dry woollen clothing is more desirable than wet, bodily moisture rarely saturates woollen clothes. When it does, they may be sufficiently dried by wringing to become available for further

Wool

condensing and absorbing perspiration. Wool withstands cold winds and through its quality of non-conduction the heat of the body is not dissipated. Valuable as these attributes are in cold climates, it is always distressing and sometimes fatal to encase in woollen uniforms soldiers on active tropical duty. This has been done in earlier years in foreign armies with disastrous consequences, and is referred to now simply as an example to be avoided. Even were heavy marching or fighting not required, the tendency to accumulate merely the normal heat of the body, radiation being lessened, is distinctly weakening in a torrid climate, and the longer that condition is maintained the greater the depression it causes. So also while the short northern summer burns, the heavy woollen coat and trousers in New York are nearly as trying as in Luzon. On the other hand, the very qualities that make wool baneful in hot and humid climates are those which give it special value in cold and windy regions. Its peculiar ability to absorb perspiration and thus, through suitable grades of underclothing, to maintain an appropriate body-temperature makes wool, in one form or another, the most important material for purposes of dress.

Disadvantage of wool

Where the climate is suitable, the chief inconvenience in using woollen clothing is the difficulty of washing it. In washing, wool is apt to shrink in fibre, so that after a time the whole becomes smaller, harder, and less absorbent. That is to say, it shrinks in all its dimensions and fails to take up perspiration freely. This bars the issue of pure woollen underclothing for the field, except at the cost of frequent renewals. The intermixture with wool of thirty per cent. cotton makes what is called merino, which is a tolerable substitute for pure wool. In washing woollens they should be put into hot soapsuds and moved about freely, then be plunged in cold water, and when the soap has disappeared be hung up without wringing. Woollens should never be rubbed nor wrung after washing (Parkes). Or the woollens

Merino

To wash woollens

may be put by themselves into lukewarm water which has abundant soap in it, but soap is not to be rubbed on the clothes. They should then be freely moved about for cleansing, and be rinsed well, without rubbing, in clean water of the same temperature and be hung to dry without rubbing or wringing. They should be stretched a little while drying to counteract possible shrinking. The soap used with woollens should be carefully selected so as to be free from excess of alkali, whose action on the natural fat would injure the wool itself.

Anti-malarial properties

There was formerly a widespread opinion that an all-wool dress is a partial preventive against the malarial poison. Whatever foundation there may be for the comparative immunity of wool-clad men, probably depends on the equable temperature thus maintained which adds to the resistance of the system and to the mechanical guard which the greater thickness of the dress presents against the mosquito. Worsted is a species of woollen cloth whose fibres are hard-twisted and parallel, of which serge is a variety. Both have the advantage of lightness combined with the good qualities of the lesser woollens. Flannel is loosely woven and soft with a nap-like surface but of various degrees of thickness. It is chiefly, but not exclusively, used for underwear. Flannelette and Canton flannel are not true flannels; that is, they are cotton and not woollen. They have a soft and sometimes long nap which adds to their warmth, and hence they sometimes are mistakenly classed as woollen goods. Closely woven cloth, whatever the material, takes up dust less readily and parts with it more easily than that of loose texture. Because they are so accessible to dust, the lighter woollens should be carefully brushed after every using, for dust may be a vehicle of disease, as it is a mark of uncleanliness.

Worsted, serge, and flannel

Shoddy is old, used, and worked-over wool and cloth and is a legitimate article of commerce with defined uses. But, besides, it frequently is mixed with fresh wool as an adulterant, to the great detriment of the manufactured product. Its presence is most easily detected by its coefficient of tearing. Such adulteration prevails under the greed which war-contracts foster and should be carefully inspected against. Tests for woollen cloth are: When held against the light it should show a uniform texture, free from holes; folded and suddenly stretched, it should give a clear ringing note; it should resist well when violently stretched; to the touch the texture must be smooth and soft; to the eye it should be close and free from straggly hair; and the heavier any particular parcel is to its superficies the better.

Shoddy

Tests

Of the auxiliary materials for military clothing, leather in its several forms is the most important. Properly tanned it is practically impervious to the wind, so that hides dressed with the hair or wool retained are wisely used in cold and rainless climates the world over as great-coats in which to withstand exposure. Civilians use the buffalo, bear, or sheepskin overcoats along our northern frontier and on the bitter plains of the northwest. Such coats, carried as public property and charged against the soldier only when damaged wilfully or by neglect, are well worth their cost in the comfort they secure to the men and the efficiency they enable the wearers to display. But except as foot-gear, dressed leather clothing, whether bison or buckskin, is fit only for rainless climates.

Leather

Heavy canvas sheds water and is an excellent non-conductor of heat, but when heavy it is too heavy and cumbersome to be convenient as a garment. Lined with wool, canvas used as an overcoat defends admirably against cold. Light canvas is well adapted for fatigue duty. When very light canvas is first thoroughly washed and then carefully soaked with oil in several successive coats, each slowly dried in the sun, it becomes waterproof.

Canvas

India-rubber is invaluable as a temporary protection against rain and wet in general. It cannot be worn persist-

India-rubber

ently because it does not allow the perspiration to evaporate, and it retains the heat of the body to a degree that in most climates is distressing. It is best adapted to temperate regions, for it loses its elasticity where the weather is very cold and it becomes distensible where it is hot. Its life is limited by its ultimate decay through the absorption of oxygen. As a water-proof sheet to intercept moisture from the ground it has great value, but some other material should be interposed between it and the body while sleeping. The rubber sheet was formerly, but is no longer, issued. A water-proofing process devised by Major Munson, medical corps, when applied to ordinary clothing enables it to shed heavy rain for several hours. It possesses the great advantage of not impairing the ventilation, so that the perspiration continues to escape insensibly by vaporization. Garments treated thus do not lose their shape, and under exposure to storm there is no sense of bearing about wet clothing. Animal fabrics respond to the process better than those that are vegetable, but the latter can acquire this protection. This attribute is destroyed by boiling water or strongly alkaline soap, but it may be resumed by re-immersion in the water-proof bath. Because of these limitations and because it does not keep out the wind, it is not constantly available; but so far as it resists all moisture without requiring an additional garment, it should be very serviceable.

Munson's water-proofing

XII

MILITARY CLOTHING: APPAREL

Head-covering

The ideal military head-covering should protect against atmospheric heat and cold, rain, the glare of the sun, and the solar heat and actinic (chemical) rays. It should be attractive on parade, convenient under arms, useful in camp and bivouac. Such has not been found in any service, and it is unreasonable to suppose that a single head-dress can ever satisfy all these conditions. The best to be hoped for is something which will fill the most important requirements according to region, season and duty. In very cold weather it should keep the ears as well as the head normally warm; it should be so nearly water-proof as to shed heavy rain, and yet be permeable by the atmosphere and permit ventilation practically equal to that enjoyed by the body; rain should be diverted from the back of the neck; and the eyes should be protected from the direct rays of light and from brilliant reflection in arid regions. Above all, in subtropical and tropical countries the head must be protected against the direct rays of the sun which carry light, heat, and actinism side by side. This is less because of sunstroke pure and simple than on account of the possible nervous degeneration that may thus be induced. In any really hot climate free ventilation over the scalp, to reduce the local temperature, is required. It has not been definitely determined, but it is probable, that under extreme heat the action of the brain and spinal cord, which are the controlling centres of nervous action, may become impaired, and, more than that, that those nervous masses themselves may undergo deterioration and that some of the fluids necessary for muscular and nervous action may also be

Tropical requirements

altered. Neither have been published definite measurements of the degree of heat found within unventilated hats and caps. But it is not an extravagant assumption that, besides recognized discomfort, such excess causes serious and disqualifying harm. These remarks apply also, but with somewhat less force, to other parts of the body and especially to the spinal cord, enclosed and protected as it is by the spinal column. The cap which of one material or the other is required to be worn in garrison and on duty, excepting when in the field, by all enlisted men is three and a half inches deep with an overhanging crown. It has a short, inclined, green-lined visor. This affords sufficient air space in temperate climates. For full-dress and dress occasions the cap is of blue cloth, but these are so rare and so temporary that their hygienic consideration may be neglected. For all other service, not field duty, the cap is of olive-drab serge or of cotton khaki. It affords no protection below the line of contact, except moderately by the visor for the eyes, and it is not adapted for extreme climates. In the field the service hat is worn. Officers not on formal duty may wear a light white cap with white outer garments in garrison.

Cap

A felt hat of the color of the service uniform with a moderately broad brim is now issued for field duty. It is nearly the equivalent of the older campaign hat, which, although not faultless, stood the test of service and proved acceptable in all climates. The crown is tolerably high, and when this is drawn to a peak (which in the older hat was forbidden in the interest of appearance), the air-space is materially increased and there is no crease to retain rain-water. In the absence of actual experience with it, the bulk and comparative weight of this hat would tend to condemn it for tropical field work; but in fact the campaign hat was popular in active Philippine service, as its successor should be. This seems due to its color, which does not unduly absorb the heat rays in the sun and at the same time is in-

Service hat

conspicuous; to its expanse, which protects the face and the neck from the weather; to its flexibility, which adapts it to the exigencies of the forest, the jungle, and the bivouac; and above all to its relative thickness, which serves fairly to bar the sun's rays.*

Protection of the head against tropical sun

To withstand the tropical sun a dense crown is desirable, which implies relatively thick material. This is preferable to a light and thin covering, if there is provision for change of air under it. The delicate straw hat or even the white cotton or linen cap, although more acceptable than the old low-lying cap or kepi with its single dark tissue on a leather crown, permits the solar heat to beat through. Tropical natives usually wear a dense hat standing away from the head or carry an umbrella, either of which interposes a barrier to the heat-rays and secures a circulation of air, or they wear a voluminous white turban whose color reflects the heat and whose entangled air is a non-conductor.

Other coverings for the head

The most hygienic of all tropical head-coverings is the white, thick, cork or pith helmet or, better, mushroom-shaped hat. The body of either stands about an inch away from the head at the nearest point, clasping it by an inner band. The hat is broad enough to shield the face and the nape of the neck and it is thick enough to prevent direct penetration by the sun's heat-rays.

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* *Historical Note.* The prototype of the campaign hat was designed by Col. Timothy P. Andrews (afterward Paymaster General) for his regiment of Voltigeurs in the Mexican War, but was first issued to the Second Dragoons in Texas in the early 'Fifties. Officers and men pronounced it then the most comfortable and serviceable military hat they had worn. The brim was very broad, and one side was arranged to loop up when required. Apparently this was done rarely, if at all. The issue was not renewed, because the regulations did not recognize the pattern. In the later 'Sixties an attempt was made to revive that hat by an experimental issue made from oral description, but the drab color of the model was arbitrarily changed to black and the material used was poor, so that it was not acceptable. The campaign hat has been gradually evolved from the Andrews, or Second Dragoons, hat, the Mexican sombrero, and the soft hat of the civilian.

But this conspicuous, cumbrous, incompressible and comparatively costly, however comfortable, hat is not one of issue. The white or drab cork helmet protects comfortably against the fierce sun but is unfit for the field. It is officially obsolete, except for the supply on hand which is issued to sedentary troops. Properly made, its ventilation is excellent and its protection admirable. The straw imitation helmet, acceptable and heretofore sometimes permitted in the hot seasons of temperate climates, is too thin to withstand tropical heat and too fragile for the field or rough service anywhere. That is also true of the common straw hat which occasionally has been authorized in garrison for local and temporary use. These are no longer authorized. Special forms of head-dress, usually designed from motives of display rather than of sanitation, sometimes used by state troops, are rarely commendable.

Cork or pith helmet or hat

Straw hat and helmet

Whenever the atmospheric temperature is very high and whatever the head-covering, the local heat may be reduced by the evaporation from a wet fabric contained in the hat crown. This simple plan materially assists in averting heat-stroke and is well worth execution on a trying march.

Cooling by moisture

Besides the reasons already suggested for guarding against the solar rays, there is cause to apprehend harm from an excess of the invisible chemical or actinic waves which accompany those of light and heat; for, just as these better known agents are themselves hurtful when too intense, it is probable that the associated rays, which are less understood, may also be mischievous where there is no dark shield. Confessedly the physiological action of actinism is yet obscure, but we are warranted in attempting to mitigate the penalty that falls upon those who pass beyond the bounds of their habitations, which are set for all the nations of the earth. The actinic rays are not only, like those of light, absorbed by opacity but are filtered out by the

Actinic influence

orange hue. While for evident reasons it would be inexpedient openly to uniform our white troops in orange and black, an orange or a black layer in any position will cut out actinic action from anything beneath it. Hence to line the head-covering with metal or other opaque substance, or with an orange sheeting, should at least intercept that chemical principle. And while the chief danger to be apprehended is to the brain and spinal cord, the whole of the clothed person may well receive this protection of orange underclothing, certainly tentatively, until the question is settled. This refers to the white and the colored man. The black carries his armor with him.

Orange and actinic rays

Orange underwear

Besides the uniform hats already described, an ordinary sportsman's canvas hat, with peaks fore and aft and folding flaps as evolved by hunters, should fulfil the requirements of the field. Neutral in color, it may be decorated if desired for display in peace, but the ornaments should be detached in war. In warm weather it would be light with abundant air-space and optional openings in the crown; but for cold seasons it should be warmly lined and the flaps turned down when desired. This would be light and portable, easily folded for transportation, and not in the way of the soldier's weapons; it would give protection on the march and a cover in bivouac; and it has stood the test of much rough usage with a reputation for comfort and durability. For the tropics such a hat would not be sufficiently resistant to the solar rays, but for the whole range of the temperate zone it offers inviting possibilities for the field.

Sportsman's hat

The closely fitting dress-coat, the modern relic of armor in its function of mechanically holding the soldier upright, was the most unhygienic and therefore unmilitary article of military costume. Fortunately it has been abandoned together with its long-discarded adjunct, the leather stock, and nothing should ever lead to

Dress-coat

the revival of either. Both were based on misconceptions. The coat compressed the chest and interfered with its expansion, restraining the soldier from the vigorous exertion to which his training is directed and his occupation requires. The stock was a continuation of the apparatus for rigidity. As with powder, pomatum, and pigtails, the product was picturesque but pernicious. Dress-coats will doubtless be retained for the time by some state troops for purposes of display and spectacular attraction, but inspecting officers should always observe and condemn those that are tight and should discourage their entrance into the field. When such regiments may be mustered in the United States service, that part of its uniform is to be rejected.

Leather stock

In the militia

The dark-blue cloth sack-coat for dress should always fit loosely; which does not mean that it should be ill-fitting or ungraceful, but that it should nowhere bind the wearer. It is difficult to cut such a coat to look well without the direct support of the body, and the tailors' constant tendency is to make it more snug, that is to have it fit more closely for the display of the figure, in which the men will abet them. Company officers should guard against that propensity as a sacrifice of the spirit of intelligent dressing which the uniform is designed to maintain. The coat itself is worn so little that it has no appreciable direct influence upon health, but its conspicuousness on occasions of ceremony sets a general style for other military clothing. Hence the importance of not setting up a model whose tendency may be harmful. The dress-coat should not be worn at home in the southern summer, nor be taken into the tropics.

Blue cloth sack-coat

The service coat of woollen or cotton according to climate, olive-drab in woollen, khaki-colored in cotton, should be at least five inches in excess of the girth of the chest at forced inspiration. The regulation requires the coat to be "at least five inches in excess of the chest measurement." But the official definition of chest measure-

Service coat

ment is the circumference after forced expiration, which would give a play of only two inches in large men, who require it most. As this is the working coat, especially in cold weather, there should be in the woollen coat a sufficient margin about the chest for adequate underclothing without interference with muscular action. The service coat is also required to fit closely at the waist, a rule requiring liberal interpretation to avoid discomfort with heavy underwear. It contains two outside pockets above and two below the waist line and is the best for its purpose that the army has ever had. Further, it possesses the great economic advantage of being identical for all arms. The hygienic question might be raised whether the skirts, which extend one-third of the distance from the point of the hip to the bend of the knee and thus are well adapted for the saddle, may not be unnecessarily short for the infantry. A short skirt may apear "smart" to the eye, but if it falls low enough fairly to clear the ground when firing kneeling it gives better protection to the abdomen.

Unconstraint in uniform

The objection that long blocked the ways to reform, was to stigmatize a loosely fitting uniform as slouchy. The abstract condition of looseness has no intrinsic influence if the cut is good, for it is the wearer, not what is worn, that offends the eye. It is "setting up," not tight clothing, that creates the martial figure; for no man held in position by his clothes is either soldierly or very vigorous. War in its practical aspect is hunting, an exercise demanding the most active and untrammelled exertion, and the hunting-shirt has been evolved as the effective and typical garb of the hunter. The nearer the soldier's working dress approaches that of his hunting prototype, the better it is for his work. Notwithstanding the coat should be loose and not tight, it should be carefully modelled and attractively made. It is not unmanly to feel pride in dress, especially when it is the badge of honorable service; but it is difficult for a man to be proud of his uniform when it is uncomfortable or ill-looking. On the other hand a neatly dressed is apt to be a well-behaved soldier. It contributes to the *esprit* of any organization for its head to recognize and commend features which less intelligent or less interested men neglect. No captain should allow one of his men to accept uniform from the company tailor until its fit has been passed upon by his First Sergeant and then approved by himself, a practice in some if not all of the better armies. Particularly should minor alterations in violation of the regulations at the whim of the enlisted men be promptly disallowed. This attention to clothing is of secondary but real importance for officers of the organized militia also. The value of these injunctions lies first in the importance of securing roomy clothes that will accommodate themselves to vigorous activity, and secondly in the stimulation of confidence in one's self and his comrades by the gratification of legitimate self-esteem.

Attention to appearance

Tight shirt-collars and tight neckbands, as well as tight standing collars of military coats, disturb the blood supply of the head, affect the vision, and may have serious consequences. They should not be worn and the neck should be kept free from the least compression.

Collars and neckbands

A cotton undershirt and a winter one of woollen are the regular issue. The winter shirt contains sixty per cent. wool and forty per cent. cotton, and when thirty-eight inches breast-measure weighs fifteen ounces, the other sizes weighing in proportion. This replaces a heavy and a light winter grade. For reasons already explained, it seems impracticable to preserve the health of men on active service if wool (merino) is not worn next the skin of the chest and the abdomen one day with another the year through, and the men should be encouraged, by preference required, to follow that habit. A knit woollen undershirt, at one time issued, was sometimes so rough as to be unbearable to delicate skins. That is wholly unnecessary, and the condition when occurring should be made the subject of official complaint by the company commander, with the view of securing a

Undershirt

more tolerable grade. Any undershirt when issued should reach half way down the thigh, for there will inevitably be some shrinkage and whatever is worn should more than cover the abdomen. Details like this must be constantly remembered, for in contract work there is frequent temptation to skimp if not to scamp the product. The material should be one-third cotton for ordinary issue and in three grades. In Alaska a fleece-lined undershirt is now furnished, and in other cold regions the soldier should be allowed to draw two sizes and in winter to wear one over the other when necessary. In hot climates the texture may be two-thirds cotton, but it is not safe to omit entirely the use of wool.

Flannel shirt

The olive-drab flannel shirt, issued as a substitute for the blue flannel shirt, is probably the most useful article of the uniform. This has a rolling collar and breast pockets, is reasonably full and resembles the hunting-shirt excepting that it is worn within the trousers. It is extremely comfortable and on fatigue may be worn without the coat. It is sometimes thus worn by authority at drill and even on short details of active duty, in both which cases the waist-belt should replace suspenders. Visible suspenders suggest negligence, as though the coat were carelessly discarded, so that besides the offence to the eye there might be an example unbecoming military order and neatness.

Removal of undershirt

Under extreme heat, when the overshirt is worn the closer-fitting undershirt may be temporarily dispensed with during the day by special authority, but not at night. A serious disadvantage is the offensive absorption by the olive-drab shirt of the perspiration that otherwise would be taken up by the undershirt.

Grades and sizes

The olive-drab shirt may properly be made in two grades, the heavier for issue in very cold climates, and in numerous sizes when some of the smaller should be without collars, that two may be worn at once.

Multiple shirts

For animal heat is best conserved by layers of air, which are poor conductors of heat, held between several superimposed similar garments. Ice-cutters and lumbermen follow this method and discard overcoats, whose chief utility is during storms or against dry cold when not much independent motion by the limbs is required. As animal heat is not influenced by color, but as dark colors absorb animal odors more freely than other shades, the clothing next to the skin should be light in color. In the field there should always be carried an extra shirt to be worn next the body, the two shirts to be worn alternately. At the close of the day's work the shirt in use should be taken off, stretched, dried, well beaten (preferably with a bunch of twigs), and hung for a time in the wind and sun. This should be done even when there is no change to be made. As the combination of perspiration and dust is disagreeable and sometimes is hurtful, drawers, stockings and breeches should be treated in the same way; and in both garrison and camp the persons as well as the underclothing of the men should be carefully inspected for cleanliness. Because the drill regulations fail to demand it, this is frequently neglected. But it is important and properly should be a formal part of company inspection in barracks, to include the feet, the stockings, the shirt and the breast. A convenient order is: *Remove both shoes and one stocking; open coat and shirt! Non-commissioned officers are excepted!* In that way those parts of the person and of the underclothing most exposed to external dust and stain are observed. If necessary this intimate inspection may be pursued further by the inspecting officer or a representative. Like most inspections, this is a preventive measure rather than one of discovery; for few men will risk the exposure of a dirty foot or an offensive shirt the second time. Dirty troops are sickly, and men who display clean shirts in their packs may wear foul clothes and themselves be unclean.

Color of underwear

Duplicate shirts

Inspection for cleanliness

Trousers for the enlisted men require little hygienic consideration as part of the uniform, for their employment involves practically no physiological strain or discomfort.

They are of light blue cloth in two grades, twenty-two and sixteen ounces respectively, worn only on dress occasions; of khaki, for garrison wear not under arms; of brown cotton duck (canvas) for fatigue; of bleached cotton duck for the Hospital Corps on ward duty. There are no service (olive-drab woollen) trousers.

Trousers

For all other purposes trousers have been replaced by breeches, which have not been in use long enough for their value to be thoroughly tested. It is worth remembering that when trousers were substituted for breeches in the British army, about a hundred years ago, "the increased comfort to the soldier was said to be remarkable" (Parkes). Those earlier breeches, also known as small-clothes, in vogue until late in the eighteenth century, encased the thighs nearly to, or just below, the knees, where they were met by long stockings. But the military breeches of to-day are loose at the knee, fit closely about the leg, and are tied just above the shoe. They are substantially what have long been known as riding-breeches, perhaps somewhat prolonged, and they are not regarded by all who wear them to be as comfortable as trousers for continuous dismounted use in garrison. Breeches are required for all occasions except those of ceremony and of garrison duty not under arms (simple duty), and sometimes by election they are worn on it. Military trousers and breeches should fit snugly around the waist, but with strap and buckle to regulate the girth. Breeches for the mounted service should be reënforced in the seat with the saddle-piece neatly sewn without rough seams, which are liable to chafe. They should be fairly close over the upper pelvis, but over the hips and in the seat there must be abundant room. Restraint, the common evil, should be minimized; for any clothing that fits closely handicaps the wearer in serious exertion. It is much better that breeches should be too large at the expense of appearance, than not large enough to avoid restraint. A broad inner belt for secondary support

Breeches

Fit of breeches

is helpful and comfortable. Pockets should be ample, with openings across the top below the belt line and not in the sides. Trousers for dress look better with no pockets at all, except a small one at the hip. There will be a temptation for the contractor to make the legs of the breeches too scanty, and thus constrain the swelling muscles, and too short near the ankles; and the men may incline to tie the extremities too tightly and thus interfere with action and also with the circulation. These possibilities the company commanders should constantly remember and frequently inspect for.

Pockets

Caution

The controlling reason for the change to this style of dress probably was the extreme discomfort that followed marching in the mud, or in dust and water, when wearing trousers, and the inconvenience in neatly stowing trousers' legs when in the saddle. When on foot the extremities of the long trousers' legs became clogged, dirty, and wet, and were an habitual trial and a frequent evil. This was aggravated by the garrison habit, unwisely overlooked, of altering the legs into "spring bottoms" for the sake of appearance. On the march, to avoid its being draggled in mud and water, the men would fold the lowest six inches about the ankle, bind it with twine and draw over it the coarse stocking-leg, which also sometimes was tied fast. The effect was to collect the mud, that otherwise would cling to the trousers, directly upon the stockings which might more easily be cleansed or changed. Where breeches are not furnished to state troops, it would be better for their trousers to be narrow at the bottom to stow within gaiters or leggings. Leggings, of canvas or cotton duck or of leather, are required for all duty except ordinary garrison service and occasions of ceremony. That is, leggings are complementary to breeches and the two must be worn together. Canvas is worn when dismounted, leather when mounted. They reach nearly to the knee and should set well over the instep, and when properly fitted are comfortable. Their essential object is to protect

Reasons for breeches

Leggings

the nether clothing against sand and dust and mud, so that the soldier's legs may be comparatively dry and clean. When not well-fitting leggings are not comfortable, and comfort is a factor in efficiency. The diversity of legs to be accommodated makes the selection, not the mere supply, of a pair important. Their manufacture by wholesale diminishes the chance of efficient variety. If the leggings are too loose they are liable to slip down, or to open and leave a space for sand and gravel to work in; if too tight, they may cause the feet and ankles to swell through the obstruction of the circulation. At any time a buckle or strap may break or be lost, so that the integrity of the legging really depends upon the constant exercise of extreme care and frequently upon very chance. The material should be carefully selected, for light canvas will wrinkle and light leather becomes too harsh after wetting. The straps would better be riveted than sewn. The practical objection to leggings, which should be well weighed, is that they are additional and somewhat complicated articles. The most serviceable clothing is the simplest, and it is always open for discussion whether two distinct pieces, in this case three, in place of one, however useful they may be after application, may not involve too much care and too much risk for their maintenance in the field, the ultimate scene of all military efficiency. When breeches are constantly worn it is found that the leggings often make the legs sore, particularly in hot weather.

Puttees

Puttees, which are not a part of the uniform, have stood the test of extensive use by all branches of the British army, especially in Asia, and are accepted by them as very satisfactory substitutes for leggings. They are long woven flannel or worsted bandages which encircle and support the leg from the ankle to the knee and protect the breeches. They require neither strap nor buckle and are easily applied after the knack has been acquired, and they adapt themselves perfectly. They are less bulky, more portable, more easily cleansed, and appear to be more serviceable than the official leggings. Some officers in the Philippines prefer the flannel puttee as, better than leggings, excluding insects and leeches which infest parts of those islands. The leather imitation puttee is such in appearance rather than in reality.

Belts and suspenders

Trousers and breeches are held in place by a belt of webbing or by suspenders. Either is optional, but with a normally slender figure a firm belt is the better, and is much more easily managed. The objections to suspenders are their appreciable pressure on the chest walls, their unremitting draught upon the shoulders, and the embarrassment to the wearer when, as sometimes will occur, they break, are misplaced, or the buttons on the waistband disappear. It is forbidden for the suspenders to be visible. The pressure upon the abdomen, sometimes used as objection against the belt, is insignificant as compared with that of the military waist-belt, a required part of the accoutrements. The belt should fit just above the hip-bones.

Drawers

Drawers, of jean in summer and Canton flannel in winter, are primarily for cleanliness and secondarily for warmth, and are issued to all arms and not, as in some services, only to the mounted men. When they are too heavy and inspection is not rigid, the soldier is tempted to discard them in hot weather to his ultimate discomfort and the occasional risk of his health. The Canton flannel drawers should be of several grades and many sizes, so that during severe cold two pairs may be worn together if desirable. In Alaska fleece-lined drawers are supplied. It is important that all drawers should be large in the seat and full over the thigh, places in which contractors are disposed to "save" material. Besides their interference with motion and their liability to be torn, those that are too small about the pelvis are sure to chafe.

Stockings

Both woollen and cotton stockings are issued. Some persons perspire so freely that woollen stockings, even in winter, become saturated with more perspiration than they can absorb, and as a consequence the retained moisture chills the feet when at rest. The men generally know which is the more comfortable for themselves, and they should be allowed to wear woollen or cotton at their discretion regardless of the season. It is more important that the stockings should fit well, for if too large the folds and creases may blister the feet; if too small the toes may be bent or the stocking-leg be drawn under the heel, causing chafes. In emergencies a carefully folded piece of muslin may replace a stocking. Wet feet may be uncomfortable, but they rarely are harmful to a man in good health who is taking active exercise, as shown in the frequent experience of gunners, fishermen, and many laborers. It is when he is inactive or allows himself to be chilled, that he takes cold. A wet skin or wet feet are more dangerous to health than dry cold, whenever the external temperature reduces that of the body beyond physiological restoration of the equilibrium. The severest frost-bite is when snow drives within the shoes or other clothing and melts there, or a soaking storm penetrates, and the man remains quiescent or asleep or, sometimes indeed, attempts to pursue his way with greatly lowered temperature. An experienced man who has broken through the ice in the bitter weather of the Northwest will not proceed until he has dried himself and his clothes, by the help if possible of some sort of fire, but stripping if necessary to get dry regardless of the temperature.

Wet feet

Campaigns are won by marching, and soldiers cannot march with crippled feet. Even in the cavalry much duty is performed on foot, and the character of the shoe is potent in maintaining or in impairing the soundness of the feet themselves. No official pattern has yet stood the test of time as faultless, so there is constant endeavor to create a perfect shoe.* Therefore, without describing what may

Shoes

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* The Superintendent of the Military Academy, in his Report for 1908, announces the issue to the cadets of a new shoe, made on a scientific model, which was highly satisfactory on a practice march and in daily use. This is well worth more extended trial in the hope that the problem has been solved. The contractors are the Stetson Shoe Company, South Weymouth, Mass.

actually be in use at any particular time, a type showing the features a military shoe should possess is presented for comparison with the passing achievement. However imperfect it may be, the use of the established regulation shoe should be vigorously enforced. If, as occasionally happens, a man cannot wear it but can wear one of a civil pattern, he should be promptly discharged. Such a man would be barefoot in campaign, for he cannot be supplied in the field from his special last, and whoever cannot take the field is a cumberer of the military ground. Where there is the regular range of sizes to draw from, such unconformable feet are to be regarded as malformed. There is no more vicious dictum than that (now happily overruled) promulgated some years ago by a very distinguished general, that the men should be allowed to buy their own shoes, for it was of no consequence what kind soldiers wore. Clearly he was thinking merely of their appearance. A command cannot sooner be crippled than by marching in the ordinary civilian foot-gear of either town or country. It is more important that every regiment of organized militia should have fitted regulation shoes, than that they should have regulation coats or breeches. It should be a requirement for every National Guardsman to keep at his armory a pair of well-fitted regulation or other tested shoes, to be supplied at the cost of the state and to be worn only when on duty and always when on duty. The want of such shoes has neutralized many a laudable attempt at prolonged marching. There should be a standard shoe, preferably in rights and lefts, to which the men should be confined. If not rights and lefts, they should be worn alternately on succeeding days. These should be in numerous sizes, and recruits should be carefully supervised in selecting them, for few recruits are competent to judge of the suitability of a shoe for the work before them, and they may easily damage their feet. A good marching shoe should have a thick, wide sole, to project beyond the upper leather: this is to protect the foot itself from the inequalities of the ground, to take up the impact

Importance of shoes

Features of shoes

of the step better than could a yielding sole, and to preserve the side of the foot from being bruised as it might be were the sole too narrow. Obviously a thick sole will wear longer than a thin one, other conditions being equal, and thus it is economical; but it is only truly economical when its weight does not limit progression. The shoe should have a low, broad heel: this to afford a stable support for the spine, whereas a high, narrow heel is insecure; to prevent stress and possible strain of the instep; and particularly to avoid throwing the weight forward upon the base of the toes, tending to bend them. The shoe should be long enough to allow the toes to stretch freely forward when the foot is extended by the weight of the body, and wide enough, particularly at the ball, for them to escape lateral pressure under any circumstances. If the toes are cramped, the immediate consequence is irritation of the joints of the outer toes, which generally leads to a bunion or corns; it sometimes induces overriding, and occasionally it causes positive dislocation of the great toe at its base. When sewed, the thread should be heavy and well waxed and the stitches numerous. The parting of the stitches often renders the shoe unserviceable before the leather itself wears out. But only brass-screwed or hobnailed shoes will withstand marching in climate and soil like those of Arizona, that is in arid regions rough with rock or covered with sand or gravel. Experienced soldiers will themselves set their marching shoes with hobnails, a technical irregularity always to be condoned. The best heels have a narrow iron rim, and the experimental adoption of rubber heels and sole-tips, to facilitate marching and to preserve the life of the shoes, might well be worth while.

Selection of shoes

No soldier, certainly no recruit, should be permitted to accept a shoe until he tests it by walking over the store-room floor. The human foot in walking may expand one-tenth of its length and one-ninth, perhaps one-eighth, of its breadth; hence it is entirely insufficient to trust to the apparent fit while sitting down, nor may the marked sizes invariably be accepted. It is probable that, like other muscles, those of the foot grow with exercise. A common fault in the shoe is an excess of leather in front of, and a deficiency over, the instep, where there should be abundant but not superfluous width. Nowhere should there be extra leather to be drawn into folds, and no rough seams. Tightness at the instep promptly creates lameness, and folds and seams will chafe and blister. When there is too much play for the foot the heel will blister, as it surely will also if chafed by a rough seam or a fold in the stocking. An efficient military shoe should possess the qualities already described and be high enough to embrace the ankle. If it has a slit and a tongue in front like a hunting-shoe, so much the better. Good shoes will last about two months in constant marching over reasonably rough roads, and much longer under more favorable conditions, and their life may be materially prolonged by minor repairs made in season. To that end the men should be formally instructed in such precautionary mending; or, if this is beyond their skill, they should be required to employ the company shoemaker. The company shoemaker's tools should be carried in the company baggage and he be supplied by the quartermaster with necessary materials at cost. His charges, fixed by the company council, should be a lien on the men's pay, and it would be good administration to excuse this important artisan from all military duty in the field except in line of battle. By mending shoes well the shoemaker may keep in the ranks far more efficient soldiers. There should be stated inspections of shoes by a denominated sergeant, and the delinquents reported to the company commander.

Life of shoes

Shoemaker

Shoes should be altered in garrison, never in the field, only by special permission after inspection before and subsequently. The desire of the younger soldiers to improve the looks of the shoe, often at the expense of its utility, must always be in the officer's mind. The campaign shoe weighs 2¾ pounds a pair, which is materially less than in some foreign armies; but it taxes the infantry heavily to bear an extra pair in the field. If the shoemaker can be depended upon, it would be much better for each man to carry an extra pair of soles; and so important is this service, that in active campaign two competent shoemakers may well be allowed every full company. The barrack shoe, or one like it, water-proofed, might be taken into camp, and men may well be taught to cobble, to apply glued patches and to keep their marching shoes well oiled and water-proofed.* Boots, formerly worn by the cavalry, have been discontinued for all enlisted men. In the tropics a light sandal for camp and garrison would be desirable; for the more nearly the foot is bare, the cooler and more frequently washed it will be. The chief practical objection to the sandal in marching is the liability to laceration in the jungle and the risk of venomous bites. The Spanish troops in Luzon appeared to use a light, open, sandal-like shoe with comfort.

Extra soles

Sandal

Good marching is the complement and sometimes the equivalent of good fighting, but unceasing and intelligent vigilance by the company officer is necessary to secure it. The first requisite is sound and well-kept feet, so that, particularly for new troops, close observation and personal attention to their care are required. The officers in attendance at the Mounted Service School are obliged not only to understand the anatomy and the care of the horses' foot but actually to learn to make and set their shoes and to trim their hoofs. An officer of infantry should not be less watchful of his men's feet than a cavalry officer is of his horses', and by frequent regular inspection he should make sure that the nails are properly trimmed directly across the toe, that corns and chafes are not developing and that the entire extremity is clean. Uncleanliness is disorder. Those to whom foreign example is a comfort, may console

Care of the feet

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* Parkes recommends half a pound of shoemaker's dubbing, half a pint linseed oil, half a pint solution of india-rubber. Dissolve with gentle heat (it is very inflammable) and rub into the shoes. If renewed once in three months, the shoes of a battalion may be kept impermeable at small expense.

themselves that the Prussian lieutenants of infantry are censured when their men are foot-sore. Anticipation of such inspection accomplishes much of its purpose, and it should be considered no more inappropriate to inspect the feet than to observe the hair with a view to its trimming, or to look through a rifle barrel for the detection of grime. When the feet are not hardened or are not accustomed to marching, they should be greased. A stiff lather of soap inside the stocking before setting out answers the same purpose, but the common yellow soap of the barrack is unfit when the skin is delicate or already broken. When practicable, to soak the feet in a strong tepid solution of alum assists in toughening the skin, but this is not available on a large scale. Less reliance should be placed on preventives than on practice. Attention to the foot and to the shoe should be habitual, and inexperienced men should be taught to march as they would learn any other exercise, by degrees. At the end of the march the feet should be washed gently, or be wiped very clean and dry. They should not be soaked in water, and usually wiping carefully with a wet cloth is not only sufficient but is better than washing them. When the skin is chafed, a blister sometimes may be averted by an exchange of stockings from one foot to the other, slightly altering the pressure, or through manipulation of the shoe. But usually it then is too late. A blister should be drained through a minute opening made by a needle at the lowest point under the outer skin. Or a worsted thread, which will absorb much of the fluid, may be introduced through the sound skin and withdrawn before exercise. In neither case should the skin of the blister be torn. Any more elaborate prevention or further treatment requires skilled attention. For positively sore feet men should promptly report sick, which will shorten the disability and relieve the misery. Men disqualified from marching by their own neglect after instruction, should be disciplined. This powder, adopted from the Germans, is sufficiently useful in preventing sore feet to be kept as

Chafes and blisters

company property and distributed by the sergeants. Of each by weight, take: Salicylic acid three parts; starch ten parts; pulverized soapstone (talc) eighty-seven parts. It is to be sifted in the shoes and stockings, but particularly in the stockings, to keep the feet dry, to prevent chafing, and to heal sore spots. It may be used more economically as an ointment.

Foot-powder

The soldier's overcoat, like that for officers, is of olive-drab woollen, double-breasted, lined, extending eight or ten inches below the knees, with a detachable hood for inclement weather. The comfort of the overcoat in very cold climates may be increased by further lining it with blanket, although this is not specifically authorized by regulation. In extremely cold regions soldiers may have issued to them blanket-lined canvas overcoats for guard duty or field service, but only when the post commander certifies that exposure to the weather would jeopardize life or limb by freezing. The slicker, a light, oiled-canvas, water-proof overcoat, is authorized for enlisted men when on duty involving exposure to rainy or other inclement weather.

Overcoat

Slicker

The blanket, from which the soldier should never be detached, is five and a half by seven feet in size and is issued in two weights. The heavy weight is five pounds. It often seems a burden when borne upon the person, and new troops foolishly discard it on the march on small pretext, to their subsequent discomfort, often to their harm. The proportion of blankets to men at the end of a day's march is a good measure of vigor and discipline. Very careful inspection is required to maintain the quality of the blanket in war contracts.

Blanket

Suits of brown canvas, the coat loose fitting, to be worn alone or over the uniform on stable or fatigue duty or with fixed guns and emplacements, and leather gloves, have protective rather than sanitary value. This is also true for the men's uniform gauntlets and white gloves.

Fatigue suits

Certain clothing has been specially provided for service in Alaska, and its issue as well as that in recent years of articles of extra warmth, as hoods, gloves, overshoes, and overcoats, especially prepared for protection against very severe weather elsewhere, has been fully justified. Formerly fifteen per cent of certain exposed garrisons were constantly off duty for several weeks each winter from frost-bite, not to speak of general inability to take the field. Now frost-bite on duty in these protected men is very rare. Under great exposure the use also of sheepskin sleeping-bags with the fleece inside is commended.

Extra clothing for cold climates

Abdominal protectors are small aprons of two thicknesses of soft flannel sewn or quilted together, to be worn next the skin over the bowels. They are sanitary preventives which materially diminish the number of those bowel affections that prevail in regions of long-continued heat. These are not issued, but they are so valuable in preserving health that they should be supplied and their habitual use required in subtropical and tropical climates, and elsewhere on occasion. They are not belts and they do not roll up, as does the flannel belt to the annoyance of the wearer and the defeat of its purpose. Nor should they be called bands. The protectors are suspended from a tape that passes around the waist and ties in front, and they readily adjust themselves and lie in place. One should be worn by day and one by night, constantly. These are not to be confused with the miscalled "cholera belts," the moral effect of whose name of sinister omen is bad in that, by constantly directing attention to a possibility, it magnifies it into an impending evil. Similar protection should be given the liver against the chill of night. This is not easily arranged, but the principle is much the same, and recognition of its importance should lead the well thus to guard against insidious sickness. Both sets of protectors equalize the warmth, so that the local supply of blood may not be deranged by a sudden depression of temperature. Even in the tropics there are appreciable

Abdominal protectors

Liver protection

diurnal changes. Besides the cooling from sharp wind against the comparatively unprotected skin, there always is a fall in the thermometer before dawn. The superficial blood is thus driven inward, and the daily repetition of this tends to congest the internal organs. As such precaution may be important in preserving health, a careful captain will provide means for its exercise.

Spinal protection

Besides the necessary protection of the head, that is of the great nervous mass, the brain, from the direct solar rays in the tropics, the spinal cord, another important nervous centre, requires defence. There is little doubt that the direct impingement upon the spine of extreme solar rays of heat, and perhaps of actinism, is harmful to the cord. Artificial shade, as from an umbrella, being impracticable for soldiers, there should be protection in the dress. Writers have recommended a narrow non-conducting pad down the middle of the back of the coat, which it is believed is sometimes done by the British in India. As a matter of precaution such a non-conductor might have an orange covering, as Woodruff suggests, to intercept the actinic rays. It certainly is important that the brim of the service hat should guard the nape of the neck. In contrast with these precautions, there is in temperate climates a practice to be forbidden. A certain group of men, chiefly of German birth or bringing up, if not restrained, will wrap their throats in cold weather in woollen scarfs or tippets. This induces local perspiration and leads to the colds they seek to avoid.

Tippets

Chamois jacket

A sleeveless chamois jacket has been recommended for occasional or special use. It appears superfluous under ordinary conditions, but such a garment, perforated, is excellent for wearing under the overshirt in cold or windy weather, when the coat is or is not worn. It is very light and is easily transported. This is not an article of issue. In emergency, the use of stout paper is not to be derided. Paper soles slipped within the shoes, and plastrons of one or two thicknesses of newspaper over

Paper

the breast and the shoulder blades, are effective against cold and wind. Newspapers laid between, or pinned to, blankets are excellent non-conductors of bodily heat.

Repair of clothing

Besides being encouraged in neatness men should be taught to mend the rents that labor and accident inflict, and to keep their clothing in repair independently of the craftsmen. Old soldiers generally do that through long experience, but all soldiers should be systematically taught to sew as carefully and as neatly as sailors, with whom it is a domestic art. The æsthetic as well as the material aspect of the soldier's dress has distinct military importance. Men may be taught that its various parts have martial significance and imply corresponding qualities in the wearer. Distinctive dress should foster *esprit* and cultivate self-respect. Soldiers should be educated to live up to their uniform and through it to recognize that, as individuals as well as in a body, they represent the Government both as examples of its dignity and as agents of its power. They should feel superior to disorderly and unkempt civilians, if proper stress is laid upon neatness and attractiveness of dress in garrison and upon its serviceableness in the field. As the best-dressed soldier is a picked man, so the best-dressed company will be an example to the others. The maintenance of a high spirit, even in costume, is an element of health.

Influence of uniform

Study of uniform

The efficiency of the service should always be under consideration, and on the subject of clothing, as on all others, officers should maintain an open mind. It cannot be held that an established condition is final either in quality or in immutability, or that change and improvement are identical. The presumption is always in favor of the *status in quo*, but there can be no progress unless thought is taken for the morrow. The officers serving with troops are those upon whom the administrative staff must chiefly depend for the results attained and the deficiencies to be corrected. Hence the adjustment of every clothing scheme is to be thoroughly tried out and, like any other plan of conduct, should have kindly and intelligent scrutiny. Apart from the nature of the materials, which is pretty well known, the essential query would be as to the simplicity or complexity of their arrangement. Beyond an increase of cost, multiple details add to the difficulty of supply in war, and when supply fails the army suffers. Reports of approval or those recommending change should be made only after well-considered study, for thoughtless complaint and immature advice are more than worthless, they are misleading.

XIII

FOOD: ITS NATURE

A soldier should be trained, but as a prerequisite he must be vigorous. His vigor depends upon his mental and physical condition, and it is maintained by constant renewal from without. Force is another expression for vigor, and "force manifested in the living body must be the correlative expression of force previously latent in the food eaten or the tissue formed." That is, there is no such condition as adding force as force to the human machine. More or less energy may be developed in man according to circumstances, but in all cases it is derived from material which after disintegration has been assimilated by the animal tissues. The energy may have been retained in reserve from a previous redistribution of the elements, it sometimes is expended nearly as rapidly as it is created, and it may within limits be stored for future use. Any exhibition of energy is attended by an expenditure of animal substance. A soldier's food, therefore, must be adequate to repair the ordinary wear and tear which accompany daily existence, it should replace any special waste, and should supply a margin for an unusual future draft. Besides, if the soldier is yet a growing lad, his food must provide for that growth. Animal heat is a form of energy, but it is so unlike the usual forms developed in mechanical and nervous action that it usually is classed by itself, so that food is commonly spoken of as the source of energy and of animal heat. These are developed partly by a very immediate breaking up and use of the food-constituents, and partly by the disintegration of existing tissue. Food also forms new tissues. Hence it is to be said that the immediate function of food is the construction of animal

Force

Object of food

Classes of food

Proteids

Carbohydrates

Hydrocarbons

Salts

substance and the evolution of energy. Food is roughly divided into the proteids and albuminoids (sometimes classed together as albuminates), of which flesh is the type but not the exclusive example, grouped as nitrogenous; the hydrocarbons (fats), and the carbohydrates (starches and sugars) grouped as non-nitrogenous; the salts; and water. In a certain sense air also may be called a food. But nearly all food as presented for use contains the different chemical classes, and it is assigned to one or the other chemical group according to its preponderance. For instance, flesh, milk, bread, leguminous plants are in the main, but not entirely, proteids. The proteids then are not identical but are similar; and viewed as food their chief value as well as their chief characteristic depends upon the contained albumen ($C_{21}H_7N_{15}C_{53}S$), a complex substance chiefly remarkable for the presence of nitrogen and sulphur. The carbohydrates comprise the starches and sugars, which have a chemical and a physiological likeness. Starch ($C_6H_{10}O_5$) is found in all the cereals, especially in wheat, oats, maize, barley, and rye; in the legumes or pulses; in rice, buckwheat, the potato, carrots, parsnips, turnips, practically in all vegetable food. Grape-sugar or glucose ($C_6H_{12}O_6H_2O$) and cane-sugar ($C_{12}H_{12}O_{11}$) are found in many vegetables. Their chemical characteristic is the fewness of the elements and the comparative simplicity of their combination, wherein they resemble starch, and by which on occasion the one may be in part transformed into the other. The hydrocarbons are the fats and oils, whose chemical feature is the excess of carbon and hydrogen and the small amount of oxygen ($C_{10}H_{18}O$) as compared with the carbohydrates. The inorganic salts are chiefly chlorides and phosphates, compounds of calcium, potassium, and sodium, not great in amount but important. They are generally supplied in composition with the ordinary alimentary substances. All of these classes, but especially the proteids, the minerals, and water, build working tissue; the organic components evolve energy; and heat is the product of cell life. In fact life is essentially a form of motion. It is maintained by the rejection of old and worn-out particles, and by the assimilation of new particles to replace these or to develop the body still further. All life is thus the manifestation of change, and the instant a tissue is microscopically at rest it is dead.

Requirements of life

To summarize the special nutritive qualities of these various constituents, we find that nitrogen must be supplied in some form; for when it has been cut off the various functions gradually languish as the reserve in store becomes exhausted. Of course the carbon, the hydrogen, and the oxygen are necessary also, for as there is no food (except the minerals in part) that does not contain these, it is impossible to eliminate them and to eat any food at all. But it is not impossible to consume food otherwise nutritious that is devoid of nitrogen. When that is done, however, there is a proportionate loss of vigor; and because nitrogen is essential to energy, intellectual capacity and bodily vigor are found only among those who use a predominating nitrogenous diet. Further, the normal interstitial changes in the human body, which might be expressed as freedom from physical stagnation, are a measure of health. These changes require the presence of oxygen and its incorporation in the tissues. Now the acquisition of free oxygen from the atmosphere appears to be conditioned by the presence of nitrogen within the body. "The absorption of oxygen does not determine the changes in the tissues, but the changes in the tissues determine the absorption of oxygen" (Parkes). All this is particularly true for soldiers, and a constant problem is to secure an adequate store of available nitrogen. It does not always happen that the most ample supply, especially if continuous, is the best; but there must be a continuous allowance of nitrogen from which to draw as required, especially in the field. The starches and sugars enter into the structure of the tissues, but preliminary thereto the starch must become

Nitrogen

Starch

sugar. This occurs under the action of the saliva, and by the aid of cookery, when the starch becomes dextrine, of identical chemical composition but of different atomic arrangement, or into grape-sugar (glucose, $C_6H_{12}O_6H_2O$). Cane-sugar ($C_{12}H_{12}O_{11}$) is also converted into grape-sugar in an early stage of digestion, and in the liver it is further transformed into animal starch or glycogen ($C_5H_{10}O_5$). The formulas which represent these chemical changes have no interest in such a work of application as this, beyond tracing the changes which actually occur. It is more important to know that starch must be thoroughly masticated, or be carefully cooked, than to remember the symbols which differentiate one state from the other.

Sugar

When cane-sugar has become glycogen, it is stored in the body to be called on as required. The part played in the system by sugar, and by starch after its conversion into sugar, is threefold: It increases bulk; its excess is transformed into fat; and under emergency sugar supplies a comparatively transient but an immediate and real access of energy.

Fat and oil

The hydrocarbons, or fats and oils, contain much more hydrogen and carbon and much less oxygen than the carbohydrates, the starches and sugars. The formula for the typical hydrocarbon is $C_{10}H_{18}O$. They are derived from, or more literally they are, the nutritive fats and oils of commerce, animal and vegetable; but it does not appear that the fat which is stored in the body is acquired from the fat which is eaten. On the other hand human fat is mainly, if not entirely, derived from the starches and sugars. When fat is taken as food it is broken up into fine particles within the intestines, through whose walls it is absorbed, but its ultimate destination is obscure. The common and probably correct opinion is that a part of it is actually assimilated in the tissues at large, not stored, and a part of it is disintegrated as fuel. It is probable that it is built into nerve and muscle and marrow, else fat would not be so urgently demanded as sometimes is the case. But its function as fuel seems the most constant and therefore the more important function. If fat is broken up into a lower combination for disposal as waste, the very act of reduction develops heat through cell-action, and that may reasonably be the final cause of its presence. To that extent it relieves the organized structures from wasting too rapidly. Without the reason being clearly explicable, fat seems to be essential to all growth and hence it is especially necessary to the immature. It is probably the non-gratification of the instinctive craving for fat, that in part makes the ration objectionable to and insufficient for young recruits. They may have no conscious recognition of the particular deficiency, but cadets and junior recruits alike should have access to such material in palatable condition. Where milk and butter are unavailable, as will usually be the case, cheese and the simpler animal fats should be supplied. In garrison, oleomargarine is acceptable and useful when properly served, and a well-managed company fund will generally furnish it. Fat itself served directly as food is commonly objectionable to the stomach in health, and its grosser forms are apt to disgust the appetite. But in association with other food and somewhat disguised by cookery it becomes acceptable and certainly is nutritious. The wise instincts of nature allow much more of the animal fats to be eaten in cold than in warm climates, while in the warmer latitudes the vegetable oils are freely consumed. But when fat, which is always digested in the intestines and not in the stomach, is in excess there it is liable to decompose. The main point to be remembered about the starches and sugars and the fats and oils is, that both groups are necessary parts of human diet and, however they may appear to have a chemical likeness, they are not interchangeable nor substitutive.

Mineral salts

The inorganic or mineral salts are chiefly chlorides and phosphates, compounds of calcium, potassium, and sodium, not great in amount but important, and excepting common salt, these are generally supplied in composition with the ordinary alimentary substances. Common salt (NaCl) is that one of this group which is required so freely that it must be supplied systematically as an article of food. Its value is notorious. It is found in every tissue except the enamel of the teeth, it assists digestion, and in part it regulates the passage of the fluids through the denser tissues. The instinctive demand for it is so urgent that when it may not otherwise be had rude men and wild animals make long journeys to acquire it. The importance of salt as a preservative of food is so great that it ranks among the supplies of war, and an enemy's salt-works are frequently as true an objective as his powder-works. Lime, a calcium compound, is required for bone and the potassium salts for blood and muscle, both being derived from ordinary food. The organic or vegetable salts are lactates, tartrates, citrates and acetates, which become carbonates in the blood and thus maintain its necessary alkalinity. The acids from which these salts are derived exist chiefly in fresh fruits and vegetables, and while their directly nutritive value is small their physiological value is important because their deficiency in the blood is followed by the serious disease scurvy. Hence it is a well-known principle of dietetics that, for the sake of their contained salts, vegetables must be supplied as anti-scorbutics.

Common salt

Vegetable salts

Oxygen

Air was referred to as in the nature of a food, although it is not commonly so regarded, because its free oxygen is carried in solution by the blood to the inmost recesses of the body where, on demand, it is yielded to the primary cell-combinations that make up the ultimate structures. As the respiratory air is impure or the proportion of fresh air is deficient, there must be inadequate nutrition; consequently a defective air-supply, whether in the crowded tenements of the poor or the poor barracks of densely-quartered soldiery, yields all the signs of anæmia or bloodlessness, which is one of the consequences of mal-nutrition. Soldiers suffer less in the aggregate than the closely-packed poor, because they must be out of doors a part of the time; but the condition is the same in kind, if not in degree. When the air is entirely cut off, the man is said to be suffocated, which is only another expression for self-poisoned; but in the preliminary stages we may properly regard him as being ill fed with the vital aërial subsistence. Water is not strictly a food, inasmuch as "it undergoes no change, no chemical alteration, in the body, and hence is not susceptible of liberating force. But it contributes to chemical change by supplying a necessary condition for its occurrence in other bodies." Water makes that solution of the food which is necessary for digestion; the tissues are bathed in fluid, and our secretions and excretions in great part escape in water. It carries the solid infinitesimal tissue-making particles all through the body and it bears away excrementitious matter. A man dies of thirst sooner than of hunger, and the wounded require water to replace an essential element that is escaping with the blood as well as to maintain a sufficient mechanical bulk in the circulating fluid. The thirst of the wounded man is also often aggravated by the perspiration he has previously lost in the severe exertion of battle. Water is further of peculiar hygienic importance as one of the most common avenues for the introduction of serious disease.

Water

The practical purpose of military dietetics is to determine the character of the food necessary for the repair of waste and the supply of energy in soldiers, the amounts required, and the form in which it is to be supplied. As the inorganic salts, sodium chloride excepted, are generally found in sufficient quantities in ordinary alimentary substances, these need not be separately considered. On the fundamental principle that the province of food is to supply bulk, energy, and animal heat, the general proposition is that carbon and nitrogen represent the required materials and that man needs about fifteen times as much carbon as nitrogen. As has been explained, nearly every food is both carbonaceous and nitrogenous, and it is ranged in

Military dietetics

Proportion of food elements

one rank or the other according to the preponderance of the element in question. Practically the proteids are the main source of nitrogen, and the fats, the starches, and the sugars supply the carbon, notwithstanding there is some carbon in flesh and a good deal of nitrogen in flour and other forms of vegetable food, and so all through the scale. Hence in theory it would be possible for a man to live on a single kind of diet. But to do that he must eat very much too much of one sort of food in order to get enough of the other. Thus confining a man to a meat diet would require him to absorb four times as much nitrogen as otherwise would be necessary in order to obtain sufficient carbon; or a bread diet would overload him with carbon while he acquired the proper amount of nitrogen. To supply the necessary nitrogen and carbon by means of only one kind of food, would require six and a half pounds of flesh, or four and a half pounds of bread, or fifteen pounds of potatoes a day, and this at the risk of disease from the surplus, presupposing the whole to be digested. The albumen of flesh must therefore be supplemented by fats, starches, sugars, organic acids, inorganic salts, etc., and bread requires flesh, fat, and the other varieties of food. The problem of all diets is to secure the proper proportion of each class and form of food at a cost proportionate to the means of the consumer or of his employer, and to utilize it without undue strain upon the animal economy. A military diet must be sufficiently palatable and digestible for long-continued use, compact enough for convenient transportation, sufficiently stable not to undergo unreasonable waste or destructive changes, and it should not be expensive.

Problem of diets

In a scientific estimate of its nutritive value the water which all food contains in mechanical combination is disregarded. The amount of such water is about fifty per cent. more than the really nutritive value of the food in question. Hence when the physiologist asks for six ounces of water-free food, the amount actually furnished should be, roughly speaking, about nine ounces. So for all practical

Water-free food

purposes the Subsistence department issues and the companies dispose of food in the commercial terms of the market and not in those of the laboratory. It is interesting however to note the calculation of water-free food that Parkes, the great English military hygienist, made for the British soldier in his two conditions of garrison and field service. Garrison life practically corresponds to the "life of activity" of the physiologists, and field service is equivalent to their standard "hard labor." This is Parkes's schedule:

	Garrison. Ounces.	Field. Ounces.
Proteids (flesh)	4.31	6– 7
Carbohydrates (starch and sugar)	11.71	16–18
Hydrocarbons (fat and oil)	3.53	3.5–4.5
Salts	1.10	1.2–1.5
	20.65	26.7–31

Minimum supply

Besides the solids, from three to five pints of liquid are taken daily. But under conditions of enforced inactivity and privation combined, life may be sustained on much less than that or any other standard for activity. Thus, during the siege of Paris, 1871, inactive civilians preserved life on one ounce of meat and ten ounces of bread per diem.

XIV

FOOD: THE CONSTITUTION AND MANAGEMENT OF THE RATION

Ration

The ration is the established allowance of food for one person for one day, and not for one meal as many non-military people suppose. It varies with the duty of the troops or their station, so that there are six formal rations. These are: the garrison ration, for troops in garrison or permanent camps; the field ration, for troops not in garrison or permanent camps; the haversack ration, for troops in active campaign in the field with limited transportation; the emergency ration, for troops in active campaign on occasion of emergency (or for instruction, not to exceed three days in one year); the travel ration, for troops travelling otherwise than by marching and separated from facilities for cooking; and the Filipino ration, for the use of the Philippine Scouts. Which of the several rations is to be used on any particular service will be directed by the commanding officer. Troops in Alaska have an additional allowance of some of the articles (but not a distinct ration), and the elasticity of the formal ration is increased through the privilege of exchanging some of its components for other articles of food. The use the company commander makes of the ration demonstrates one form of his administrative ability, as well as the degree of his interest in his men. Should the ration prove inadequate at some particular occasion, other articles of food may be added or the allowance be increased through the agency of the company fund. This fund is the gross amount of money received from all sources by the company as an organization. The ration as consumed may be directly increased by pur-

Varieties of the ration

Management of the ration

Company fund

chases from the company fund itself augmented by the sale of certain unconsumed components, as bacon, sugar, coffee, vinegar; by adding produce from the gardens, when circumstances permit their cultivation; exceptionally by the results of hunting and fishing; and by the company's share in the profits of the post bakery and the post exchange, which go to the company fund. The soldier's pay is never "stopped" for the purchase of food, no "messing fund" is collected from the men, and voluntary contributions are very rarely made or desired. The undrawn components, technically known as "the savings," of the garrison, travel, or Filipino ration are purchased by the Subsistence department at the current prices of the component, not of the substitutive, articles; or rations actually drawn but not consumed may be sold in the open market and other food may be purchased; or such unconsumed rations may be bartered for food in kind. It is forbidden to make savings with the object of purchasing elsewhere any article of the ration carried by the commissary, and the wisdom of that regulation is apparent when it is remembered that, although sold under the same name, the cheaper article is apt to be of an inferior grade. But food not carried by the commissary, as well as additional supplies of subsistence stores, to add to the variety or the volume of the mess, may be bought with the company fund. No savings are allowed for troops on United States transports, and back rations are not issued nor are savings allowed in the field.

Savings

The consumption of the regulation ration in garrison is so variable owing to barter, sale, purchase, cultivation, etc., that it is impracticable to judge of its fitness in one place from its suitability in another. The idea that prevailed with some students of military economics that the regular ration, even before it reached its present liberal proportions, was over-abundant received its greatest color from the excess of fat and salts in the bacon and from the consequent possibility of disposing of part when all bacon was issued. In the field, where it is the most important and where

Adequacy of the ration

back rations are not issued nor can savings be technically acquired, when owing to the exigencies of the service rations are not drawn, the food supply is the least elastic. But, as explained later, there is provision for the issue of extra food within certain limitations of time and expense, when necessary for the health and comfort of troops after they have been deprived of the garrison allowance. In garrison, because the ration may seem in excess the temptation is to accumulate savings. Such accumulation is laudable when made in prevision of occasions of scarcity or of monotonous diet, but to accumulate a great fund at the expense of the mess-table is not true economy. It is especially to be remembered that coffee and sugar should be saved only when the proteids are so low as to require the transmutation of those comparative luxuries into nitrogenous food. The practical question at the bottom of any discussion of the ration must always be: Are the meat and the bread sufficient? When of good quality, the beef ration *is* sufficient, especially when issued in amounts that make little relative wastage. When issued as soft bread, the regulation ration of eighteen ounces is not always sufficient for emergencies; but this may be increased in the discretion of the council of administration to twenty ounces, by using the bakery savings. During a part of the Civil War it was found necessary to increase the bread ration to twenty-two ounces of soft bread or flour. At the same time to every hundred rations was added thirty pounds of potatoes. The present allowance of fresh vegetables for garrison and field use is still more liberal; but unfortunately questions of transportation, markets, and other difficulties sometimes limit their issue in the field where they are most needed.

Fresh vegetables

The authorized garrison and field rations, the latter being somewhat less elastic, are set forth in the following tables; but as the ration may at any time be changed by regulation, these cannot be accepted as final.

Garrison and field rations

TABLE OF GARRISON RATIONS

		Per ration. oz.	Per hundred. lbs.
	Beef, fresh	20	125
or	Mutton, fresh	20	125
or	Bacon	12	75
or	Bacon in Alaska	16	100
or	Salt pork in Alaska when desired	16	100
or	Salt beef in Alaska when desired	22	137.5
or	Canned meat, when fresh cannot be supplied	16	100
or	Hash, corned beef, when fresh meat cannot be supplied	16	100
or	Fish, dried	14	87.5
or	Fish, pickled	18	112.5
or	Fish, canned	16	100
or	Chicken or turkey, dressed, on national holidays when practicable	16	100
and	Flour	18	112.5
or	Soft bread	18	112.5
or	Hard bread, when flour or soft bread cannot be supplied	16	100
or	Corn meal	20	125
and	Baking powder	.08	.5
and	Beans	2.4	15
or	Rice	1.6	10
or	Hominy	1.6	10
and	Potatoes	20	125
and	Potatoes in Alaska	24	150
or	Potatoes, canned	15	91.25
or	Potatoes, canned, in Alaska	18	112.5
or	Onions, in lieu of an equal quantity of potatoes, but not exceeding 20 per cent. of the whole issue.		
or	Tomatoes, canned, in lieu of an equal quantity of potatoes, but not exceeding 20 per cent. of the total issue.		
or	Other fresh vegetables (not canned), when obtainable in the vicinity, or they can be transported in a wholesome condition from a distance, in lieu of an equal quantity of potatoes, but not exceeding 30 per cent. of the total issue.		
and	Prunes	1.28	8
or	Apples, dried or evaporated	1.28	8
or	Peaches, dried or evaporated	1.28	8
or	Jam, in lieu of an equal quantity of prunes, but not exceeding 50 per cent. of the whole issue. But at least 30 per cent. of the issue to be prunes, when practicable.		
and	Coffee, roasted and ground	1.12	7

		Per ration. oz.	Per hundred. lbs.
or	Coffee, roasted not ground	1.12	7
or	Coffee, green	1.4	8.75
or	Tea, black or green	.32	2
and	Sugar	3.2	20
and	Milk, evaporated, unsweetened	.5	3.125
and	Vinegar	.16 gill	2 qts.
or	Pickles, cucumber, in lieu of an equal quantity of vinegar, but not to exceed 50 per cent of the total issue.		
and	Salt	.64	4
and	Pepper, black	.04	.25
and	Cinnamon	.014	.875
or	Cloves	.014	.875
or	Ginger	.014	.875
or	Nutmeg	.014	.875
and	Lard	.64	.4
and	Butter	.5	3.125
or	Oleomargarine	.5	3.125
and	Syrup	.32 gill	1 gal.
and	Flavoring extract, lemon	.014 oz.	.875
or	Flavoring extract, vanilla	.014 oz.	.875

The non-edible articles, soap and candles, formerly technical components of the ration, are now supplied otherwise.

For convenience, the field ration, supplied troops not in garrison or permanent camps, is set forth before taking up the components which are embodied in these tables; for the minor or subsidiary rations are but variations of the two great groups.

TABLE OF FIELD RATIONS

		Per ration. oz.	Per hundred. lbs.
	Beef, fresh, when procurable locally	20	125
or	Mutton, fresh, when procurable locally	20	125
or	Bacon	12	75
or	Canned meat	16	100
or	Hash, corned beef	16	100
and	Flour	18	112.5
or	Soft bread	18	112.5
or	Hard bread	16	100
and	Baking powder, when ovens are not available	.64	4
and	Yeast, dried or compressed, when ovens are available	.04	.25
and	Beans	2.4	2.4

		Per ration. oz.	Per hundred. lbs.
or	Rice	1.6	10
and	Potatoes, when procurable locally	16	100
or	Potatoes, canned	12	75
or	Onions, in lieu of an equal quantity of potatoes, but not exceeding 20 per cent. of the whole issue, only when procurable locally.		
or	Tomatoes, canned, in lieu of an equal quantity of potatoes, but not exceeding 20 per cent. of the whole issue.		
and	Jam	1.4	8.75
and	Coffee, roasted and ground	1.12	7
or	Tea, black or green	.32	2
and	Sugar	3.2	20
and	Milk, evaporated, unsweetened	.5	3.125
and	Vinegar	.16 gill	2 qts.
or	Pickles, cucumber, in lieu of an equal quantity of vinegar, not to exceed 50 per cent. of the total issue.		
and	Salt	.64	4
and	Pepper, black	.04	.25

Sufficiency of the ration

Opinions on amounts of flour, meal, tea, potatoes

It is probable that the ration of to-day, as set forth in the preceding table, substantially fills all the reasonable requirements of an efficient military force, and that the extreme elasticity needed for the great geographic and climatic range over which our troops serve has been attained. When this ration is properly cooked it would appear that, regardless of minor modifications which experience may show desirable, so far as subsistence is a factor an effective and well-satisfied army may be guaranteed. It is a possible question whether, in time of war, its cost and profusion may not interfere with its actual distribution. Still, intelligent comment is always in order, looking sometimes to re-arrangement, occasionally to omission or addition. When the ration was not so elaborate, medical officers of experience expressed the opinion that the flour or soft-bread component should always be twenty-two ounces, except when on fatigue, when it should be twenty-four ounces; and that thirty pounds of flour should be added to a hundred rations of hard bread (4.8 ounces to the ration), so that occasional soft biscuits or rolls might be made. The bread ration has not been quite sufficient for a hungry, vigorous man, although the vegetables now issued more nearly fill the demand. Hard bread is issued now only as a substitute for flour, presumably where flour cannot be utilized, as in the field or in a garrison emergency. Where there are facilities for baking biscuit when hard bread is issued, the suggestion would certainly be acceptable if not directly necessary to be carried out. When corn-meal is issued they thought twenty-four instead of twenty ounces should be the allowance. They also thought that sixty pounds of potatoes to the hundred rations (or 9.6 ounces instead of the 16 ounces then, and the 20 ounces now, to the ration) would be sufficient. The increased ration of potatoes, when actually supplied, should be observed with great interest; for it would appear that there is some risk of an over-issue of starchy food. The officers cited also advised that the two pounds of tea to the hundred rations might be reduced to a pound and a half, or .24 ounces instead of .32 ounces to the ration. If tea is ever seriously taken up as a part of the American soldier's diet, the allowance should be increased probably to one ounce, especially for the field.

Proportion of fresh and salt food

It has been an approved custom of the service, but one not required by the regulations, to issue fresh meat seven and salt meat three days in ten. Salt meat other than bacon is no longer issued (except in Alaska), but some form of preserved fish may be substituted. The proportion of the various articles is in the hands of the company commander subject to oversight, as required, by the commanding officer. The health of the troops and the pecuniary interest of the Government are the special points to be considered, the latter being subordinate; but in the military service above all others there should be no unnecessary expense, and it is easy to cause discontent with the plainer fare of the field by unwise profusion in the posts.

Besides the field ration proper, there are also arranged for field use the haversack ration and the emergency ration. The haversack ration consists of:

Haversack Ration

	Oz.
Bacon	12
Hard bread	16
Coffee, roasted and ground	1.12
Sugar	2.4
Salt	.16
Pepper, black	.02

Haversack ration

Relation of quantity to time

Coffee and sugar

Bulk of bread

Presumably the haversack ration will be issued to troops marching light at a distance from a field base, or in immediate touch with the enemy, where the trains are inaccessible. It is probable also that it will be required to cover a longer period than nominally allotted. Meagre as it appears beside the normal field ration, if properly cared for it is adequate during a reasonable period for mature men (not growing lads) who start out in good health. It has repeatedly been demonstrated that five days' full rations of hard bread, bacon, and coffee, which is practically the haversack ration, especially if a little pea meal is added for soup-making and tobacco for those dependent upon it, will maintain with trifling loss of weight the health and vigor of men actively engaged for at least ten days. The half-ration contains rather more of the food elements than a mere subsistence diet calls for, and the animal reserve may be drawn upon to yield extra exertion. But the loss must be made good subsequently. As issued, there does not appear to be quite enough coffee nor quite enough sugar, especially when reckoning with the inevitable waste from the mode of carriage. It would be better to increase the roasted and ground coffee to 1.5 ounces; and the sugar to at least 3 ounces, when one remembers that sugar is certainly a real, although somewhat temporary, producer of energy. A serious embarrassment with all rations borne upon the person is the bulk of the bread component, which can only be taken as hard bread or biscuit. Five days' rations would represent five pounds of bread, and this can most economically be stored in stiff pasteboard cartons. If these are

Incomplete rations

Food minimum

half-pound packages, two or more may be carried at the outset in the pockets to relieve the haversack. It is not believed that this ration can be materially reduced, but the soldier should be accustomed to think that five days' standard food may mean in fact ten days' actual provision, supplemented possibly by regulated foraging. After fatal casualties the haversack contents should not be lost. The field regulations properly announce: "During active operations troops should not expect to receive complete rations at all times. There will be . . . irregularities and reductions in rations. Not all of the swiftly changing conditions can be foreseen; consequently, occasional failure in the most careful arrangements is unavoidable." (F. R. 362.) Theoretically the minimum amount of food is eleven ounces a day, and the maximum time is one week, for thus sustaining life and vigor; but no such relation can be faced with equanimity for an active army. It is probable that the Army of Northern Virginia in the Petersburg trenches, during the winter of 1864–5, developed the minimum that an American army ever endured for a considerable period with no appreciable loss of its combatant qualities. But just what that limit was has not been satisfactorily determined.

Compensatory rations

Although company savings cannot be made and back rations as such are not issued in the field, practical recognition is made of the physical waste that always follows subsistence upon the haversack rations and frequently succeeds prolonged dependence upon the field ration. When it is necessary for the health and comfort of the troops who have been required to subsist upon field or haversack rations, the commanding officer may in his discretion order the issue in kind, within sixty days from the last date when they were thus subsisted, of specified subsistence stores whose money value equals [does not exceed] the difference between the price of those rations that were used and the price of the same number of garrison rations (A. R. 1218). This is independent of and additional to the ration issues being made, and will materially diminish the ultimate strain following prolonged subsistence upon the lighter supplies.

Emergency ration

For instruction

Composition

In anticipation of the possible lack of all other food, every soldier on active campaign carries, in addition to the rations specially required, an emergency ration. This is contained in a sealed metal case, which may be opened only by an officer's order or in extremity. It is not to be eaten when regular rations are obtainable, excepting that for purposes of instruction it may be used, to the exclusion of the regular ration, on one day in each alternate month in the season of practical instruction, not exceeding three days in each year. The ration and case weigh a trifle more than one pound. The latest published official account of the emergency ration is: It consists of three ounce-and-a-half cakes of equal parts of pure chocolate and pure sugar, and of three four-ounce cakes of meat and wheat. These meat-and-wheat cakes consist of sixteen parts of specially prepared meat-flour, thirty-two parts of coarse wheat powder, and one of salt, all by weight, homogeneously mixed. With these, separately, are three-fourths of an ounce of fine salt and fifteen grains of black pepper. The meat and wheat may be eaten dry, or may first be stirred into cold water; or one cake may be dissolved in three pints of water, boiled at least five minutes, seasoned, and taken as soup; or one cake may be boiled five minutes in one pint of water, to make a thick porridge. This may be eaten hot or cold, or when cold it may be sliced and fried with any available fat. This ration is perfectly adapted to its purpose of maintaining life and energy for a single day, but it is not competent as a constant diet. The chief difficulty in its management is the disciplinary one of preventing its misuse or loss by inappreciative troops. This implies frequent inspection. For convenience of comparison the British emergency ration and the German iron ration are here noted. The British emergency ration is contained in a small tin cylinder and consists of four ounces of pemmican and four

British emergency

of chocolate paste. The package weighs ten ounces.* The German iron ration contains nine ounces biscuit, seven ounces preserved meat or six ounces bacon, three and one-half ounce preserved vegetables, seven-eighths ounces each of coffee and salt. With its packing it weighs one pound, ten ounces.†

German iron

Travel ration

The travel ration is issued to troops travelling otherwise than by marching, when separated for short periods from facilities for cooking. Ordinarily such journeys would be by steam transportation, when water for making coffee could be obtained from the boiler. The travel ration is ample for the moderate period of its use and the sedentary condition of those who use it, and as constituted it has no especial claim for hygienic comment. Its components are:

TRAVEL RATION

		Per ration. oz.	Per hundred rations. lbs.
	Beef, corned	12	75
or	Hash, corned beef	12	75
and	Soft bread	18	112½
or	Hard bread	16	100
and	Beans, baked	4	25
and	Tomatoes, canned	8	50
and	Jam	1.4	8¾
and	Coffee, roasted and ground	1.12	7
and	Sugar	2.4	15
and	Milk, evaporated, unsweetened	.5	3⅛

During movements of concentration, troops travelling by rail or boat carry one day's allowance in excess, to provide subsistence on the first day after their arrival.

Filipino ration

The Filipino ration, for issue to the organized Philippine Scouts, has been arranged for their lighter physique, for the demands of the climate, and for their general habits, and is in better accord with the native dietary than is either the garrison or the field ration. It appears well

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*Notter and Firth: *Hygiene*, p. 902.

†*Op. cit.*, p. 904.

suited to their needs. Any alteration should be the addition of one ounce of sugar and a moderate quantity of some vegetable oil. It is as follows:

FILIPINO RATION

		Oz.	
	Beef, fresh	12	
or	Bacon	8	
or	Canned meat	8	
or	Fish, canned	12	
or	Fish, fresh	12	
and	Flour	8	
or	Hard bread	8	
and	Baking powder, in the field when ovens are not available	.32	
and	Rice	20	
and	Potatoes	8	
or	Onions	8	
and	Sugar	2	
and	Vinegar	.08	gill
and	Salt	.64	oz.
and	Pepper, black	.02	

On transports

Troops on transports are fed from the garrison rations, varied by the substitution of other authorized subsistence stores of equal money value; but no savings are allowed on United States transports. (A. R. 1222.)

Prisoners of war

Every prisoner of war is entitled to one ration a day "according to the station" (A. R. 1219), which appears to mean that he should receive a field ration while with his captors in the field and a garrison ration while in a fixed camp or a permanent prison. This is confirmed by F. S. R. 731, which provides that, failing a special agreement between the belligerents, "prisoners of war shall be treated as regards food . . . on the same footing as the troops of the government which has captured them." Literal compliance may sometimes work unintentional but serious harm, besides being uselessly expensive. At the commencement of every war a prisoner's ration in two grades should be formulated: One for men in sedentary confinement, and one for those whose labor may be utilized (F. S. R. 730), and it is important that this food shall be, as nearly as may be, of the same general character as that to which such prisoners have been accustomed. It is inexpedient to cite instances where this has not been done.

The demand sometimes made for special rations for both the high and the low latitudes usually depends upon failure to distinguish between the food allowed and that consumed. The ration is so elastic that, with the additions assigned for Alaska, it is adaptable for all service. It would be unwise suddenly to impose upon white troops temporarily stationed in the tropics a diet identical with that of natives of those regions, who have become habituated to their food by the experience of generations. It is probable that the excessive use of starches to the exclusion of flesh in our extra-continental possessions depends upon financial as well as upon climatic considerations. There should, however, be a general modification of the consumed ration to correspond with this rule: In tropical countries carbohydrates form the staple; in temperate climates a fairly mixed dietary is the most serviceable; along the arctic lines the hydrocarbons or fats, the fuel foods, are required.

Tropical ration

Concentrated foods, of which the emergency ration is an example, develop force but do not replace tissue-loss, nor do they add to the weight of young men. Troops operating under their spur must afterward have sleep and the carbohydrates. This is important and has been practically recognized in the provision for temporarily increasing the food supply in the field, when necessary for the health and comfort of the men who have been subsisting on a lighter ration. When possible it would be wise to make the compensatory issue before health is appreciably lowered, for it is more economical to preserve energy than to restore it. The rest of sleep is potent to neutralize fatigue, and men returning from hard duty on light food should have ample opportunity, by special authority if necessary, for abundant sleeping.

Concentrated food

Compensation

Pea-sausage

Meat biscuit

Pemmican

The German pea-sausage, formerly highly extolled as food for marching troops, is probably over-rated as a constant diet. It consists of pea-flour, fat pork, and a little salt. It is issued cooked and is readily made into soup. Used habitually it may induce flatulence and sometimes diarrhœa, and the men generally tire of it soon. Parkes says that a palatable meat biscuit, that will keep unchanged for four months, may be made by cooking (probably boiling), and then baking one pound each of flour and meat, a quarter pound of suet, a half pound of potatoes, and a little sugar, onions, salt, pepper and spices. The time limit probably partly depends upon the climate. Pemmican, which consists of well-dried lean beef, shredded, mixed with tallow, charged with currants or similar fruit, or sugar, and compressed into compact cakes, contains much nutriment in moderate bulk and keeps indefinitely. It is peculiarly suited for arctic service, and is well adapted for winter expeditions in Alaska as a substitute ration.

Beef extract

Kola and coca

Related to food are substances designed to prolong strength. Among these (of which alcohol is not one) are: The extract of beef, so-called. This is a heart stimulant and relieves the sense of fatigue, instead of acting as a true food. It might make a minor emergency ration for special occasions, such as picket duty and forced marches. It would be particularly useful after battle, and if every man, or a certain proportion in a company, could be led to preserve upon his person one package of the extract there would be an immediately available supply for the wounded. The kola nut alone or in combination relieves the sense of weariness and brings into action reserve muscular power. Coca (not cocoa) leaves have a similar quality. Kola and coca do not create force, but they develop or unmask that which was latent or had been shrouded; and it is demonstrable that under their influence such continuous exercise as marching may be maintained far beyond ordinary limits. The condition thus developed resembles the physical exaltation, without the mental aberration, of delirium. The ordinary sense of fatigue is the effect upon the nervous system of the circulation within the body of broken-down tissues. Neither the kola nor the coca can directly remove such débris from the blood, but they appear to neutralize the nervous impression. On that account an appeal to this expedient should be limited, and be followed by adequate rest for the elimination of the fatigue-products. For the same reason its employment must be strictly controlled by orders and its distribution be superintended by officers or trustworthy non-commissioned officers. As the active principle of coca is the dangerous narcotic cocaïne, the peril of its indiscriminate use is apparent; but, as with gunpowder, dangerous agents may be valuable under judicious control. There is on the market a reputable Forced March Tabloid containing these principles, which is worthy of careful consideration.

Multiplicity of articles in the various rations

In the effort to secure an adequate ration it is probable that the pendulun of supply has swung too far. The garrison ration contains fourteen staple and three subsidiary items. There are besides twenty-two principal and four minor substitutive articles, or a total of forty-three kinds of food that may be drawn upon, independently of others purchasable through the company fund. The weight of the regular ration as found in the market would be four and a half pounds, and as placed on the table its minimum is three pounds of solid food. Without question the United States army in garrison is the most amply supplied with food of any in the world. Whether it is the best fed, is a question of cooking. A possible result of this bountiful, not to say prodigal, ration may be a temptation to wastefulness and an unreasonable dissatisfaction when active service reduces the variety. The field ration contains eight staple and twelve substitutive articles, besides four that are minor, whose weight is nearly four pounds. Judiciously cooked this is ample even for the strain of the field, but in the nature of the case it

Garrison

Field

must happen that the pound of potatoes frequently, and the pound and a quarter of beef sometimes, will fail. The haversack ration weighs practically two pounds, and, as already noted, is quite adequate for short periods. Its chief drawback is bulk, not weight. Five pounds of hard bread (for five days) is not easily carried upon the person, but even to lighten the weight it would be unwise to diminish the allowance. Pack animals may carry extra hard bread with rapidly moving columns, and impervious bags within the haversack are desirable for bacon, ground coffee and sugar.

Haversack

Food that shall be fit and sufficient is the first essential for an army. More important than clothing it is more critical, except for the moment, than ammunition. The Subsistence department must depend for its final knowledge of the working value of the ration upon the company officers' reports. For a long time to come those officers, neither necessarily content nor yet dissatisfied with the components as received, should scrutinize them, looking to greater efficiency and the elimination of the inutile, and their carefully considered opinions should go as reports to the General Staff. A slovenly report hurts the maker and may deceive the recipient. It certainly does no good. Every company officer's first duty is to appreciate the ideal ration and above all how it should be treated before it reaches the mess-table. Nothing should be beneath his care that may add to the real comfort and efficiency of his men, but that comfort and especially that efficiency are not furthered by superfluities.

Study of the ration

XV

FOOD: THE MEAT COMPONENTS OF THE RATION AND THEIR TREATMENT

All parts of the ration except bread are estimated raw. The ration of beef weighs a pound and a quarter and is sufficient when the quality is good. There is a waste of five per cent. in cutting up the carcass, and a fair proportion of bone, which is included in the ration, is 20 per cent. Of this bone a certain part may be used in making soup, but usually bone is not regarded as a part of the consumed food. In cooking, meat shrinks in varying degrees, a reasonable average of such loss being 25 per cent. of the gross weight. Steers are issued by preference, and when slaughtered for food they should be about four years old, full grown, and well nourished. The live weight should be about 1000 pounds; but frequently smaller cattle must be accepted, especially in the field. The weight is best determined by putting average specimens on the scales. The average net weight is 60 per cent. of the live or gross weight, and when neither can be determined otherwise this formula may be used for the dressed carcass:

Beef

Loss in serving

Weight

$$C^2 \times .08 \times L \times 42 = W \text{ (net).}$$

Here C represents the girth in feet behind the shoulder-blades, or the mean circumference; L is the length in feet from the front of the shoulder-blades to the root of the tail; 42 is the weight in pounds of a cubic foot of flesh; and W is the net weight. The carcass is substantially a cylinder, and the area of the circle is obtained by multiplying the square of the circumference by .07958, or practically .08. The content in cubic feet then is the product of the section area multiplied by the length, and this multiplied by 42 gives the weight in pounds. A variant of this is: $C^2 \times 5 L \div 1.5 = W$. When using this divide by 1.425 if fat, or by 1.575 if very lean.

Fresh beef

More labor is involved, but the results are better when freshly killed beef of good quality is issued. In temperate climates beef should be killed twenty-four to thirty-six hours before issue; in hot climates not more than eight or ten hours. Good beef should have about 20 per cent. bone; the fat should be sufficient but not in excess, and in color not dead white but rather approaching a light straw; and the flesh should be firm, elastic, and marbled with little veins running through it. From good meat on a white plate a little reddish fluid will exude for several hours. This is a good, not a bad, sign as sometimes supposed. The flesh of young animals is moist and pale and that of older ones is darker, but a deep purple indicates that the animal has not been slaughtered, but has died without the blood draining off. Blood is objectionable, not because in itself it is unwholesome, but because it decomposes very rapidly. Besides, where the blood has not escaped during life it is a sign of death by disease. None of the meat should be livid, and the interior should be of the same color or a little paler than the surface. Softening, a sticky fluid, or, above all, pus, indicates decomposition. An easy test of suspicious meat is to pierce deeply with a long clean knife. This should meet equal resistance at every point and no disagreeable odor should cling to it. If the meat is softer in one place than another, putrefaction is beginning. In recognizable putrefaction the color at first is paler and later it is greenish, and the odor is offensive. "In temperate climates the marrow of the hind legs is solid twenty-four hours after killing: it is of a light rosy red. If it is soft, brownish, or with black points, the animal has been sick, or putrefaction is commencing. The marrow of the fore legs is more diffluent; something like honey, — of a light rosy color." (Parkes.) Mutton, an alternative for beef,

Signs of bad meat

is more easily observed because of the smaller bulk. Sometimes the sheep are so fat that there should be a special clause in the contract requiring the surplus to be removed before acceptance.

Mutton

The issue of meat in garrison is a matter of simple routine. In the field it is customary to supply fresh meat on alternate days, if possible. If there are sub-bases stocked by rail or water, supply from them is also comparatively simple, for in cool weather beef may be distributed in wagons. In warm weather the haul should not exceed two hours, unless ice is available. When cattle are acquired from the surrounding country they are slaughtered as required. Sometimes herds are driven with marching columns and drawn upon as necessary, but such beef is usually less satisfactory than that otherwise supplied. Cattle following marching troops are ill fed and become tough from constant walking. In the tropics the native beef is meagre in amount and poor in quality. Hence for the Philippines frozen or refrigerated beef is supplied from the United States or Australia.

Field supply

Tropical supply

There is an essential distinction between refrigerated, or chilled, and frozen meat. When beef is chilled the carcass cools naturally, after which the temperature is gradually lowered below the freezing point, which inhibits bacterial action and consequent decomposition, and the meat is stored or carried in refrigerating chambers whose temperature is uniformly a little below freezing. Beef thus treated retains its nutritive qualities and is very acceptable. There is a probable limit of time after which this meat deteriorates, but that has not yet been definitely fixed. Clearly, the time of its availability is considerable. Frozen beef is subjected to a constant temperature of from 20° to 10° F. When thawed out, as it must be before any use can be made of it, the nutritive juices drip from the sections and the flesh becomes pink through the diffusion of the coloring matter of the blood. But frozen mutton because unquartered

Chilled meat

Frozen beef

retains these juices. Frozen meat deteriorates because it is frozen, and it is not particularly acceptable, although it is better than no meat. There is reason to suppose that histological changes occur in solidly frozen muscular tissue even after a month and that these are progressive. At least in fowls many fibres are scarcely recognizable at the end of six months. This change probably occurs, although not so rapidly, also in mammals. The ration of frozen meat is not as nutritious, weight for weight, as that which is fresh, and the loss in cooking is about 10 per cent. more than with fresh meat.

To cook meat

Nearly all flesh is converted into food by the action of heat (the exception being the dried or jerked meat of certain arid, almost anhydrous, regions), and the more usual processes are those of roasting, baking, boiling, stewing, and frying. The true cooking temperature, except for frying, should not be above 170° F. At the outset greater heat is required in certain cases. But hard frozen meat requires care and time to reduce it to the normal before the cooking itself begins.

Soup

Soup is a form of food economical of material, easy of assimilation, and when properly made acceptable to the taste and invigorating to the body. It is not popular with our soldiers, chiefly because so often it is ill made, but partly from the prejudice that it is not "solid" food. The men have not been used to it at home. Good soup, not greasy slops, is so valuable as food that no pains should be spared in cultivating the art of making, and in developing the habit of taking, soup by the rank and file. To make soup, uncooked meat in moderate-sized pieces, at the rate of one pound to a quart, should be put into cold water and after soaking for an hour be heated gradually and cooked slowly. This extracts the natural juices. Hard boiling drives off the aroma and probably part of the nutritious matter, and if the temperature has been raised quickly the meat may be toughened. Cracked bones, whose marrow dissolves in the soup, increase its strength. Small pieces of cooked meat may be added three-quarters of an hour after the soup is put on the fire; vegetables except potatoes may be introduced one hour and a half, and potatoes half an hour before it is finished. The more fragments of cooked or uncooked meat and broken bones that are added, the better. A scrupulously clean pot, slow cooking, and constant skimming are the essentials of soup-making. Soup stock, from which soup is most conveniently made when it is an habitual part of the diet, is made by putting lean meat in cold water, three pounds to a gallon, and cooking slowly for several hours. The fat is skimmed off and a jelly remains after cooling. This is redissolved by heat and reboiling, after the addition of water. Seasoning is added as required. The stock-pot should always be kept up in garrison; and, although it is rarely done, such stock can be prepared in camp and be carried on the march so as to be immediately available when camp is again made.

Soup stock

For boiling, the pieces (of any meat) should be as large as possible and be plunged into boiling water. The action of the heat coagulates the albumen in the exterior layer of the meat, which thus retains the interior juices. After five minutes the heat should be reduced to 160° F., and it should never be allowed to reach 170°. Above 170° the flesh shrinks and the meat becomes hard and indigestible. Of course the interior of a large piece of meat is cooler than the surface and the surrounding water, and a little time is required to raise it to the proper temperature, which should be about 160°. If it is much under that it will be underdone. But the constant tendency of soldier cooks is to use too much heat, and company inspecting officers should make use of the kitchen thermometer. Meat is much more effectually prepared for the table at the lower temperatures, to which it should be subjected for fifteen minutes for each pound in weight. Hence so-called boiled meat is not, or should not be, boiled. Apart from the disadvantage of coagulating the albumen, as already pointed out, it is evident that it is entirely unnecessary in any form of cooking for the

Boiling meat

heat to reach 212° F., which is the boiling point of water at the sea level and is conventionally reckoned the common boiling point, when the decrease of temperature with the increase of altitude is considered. With the reduction of the atmospheric pressure, water boils at 1° F. less for every 600 feet, or 1° C. less for every 1080 feet, of elevation. Hence boiling water at Fort Logan or Fort Douglas is not as hot as boiling water at Fort Monroe, but the cooking at the two stations is practically identical. It follows that the sign of actually boiling is fallacious. Simmering, as a term to indicate a temperature less than boiling, is delusive. Water that simmers is boiling very gently, and is practically as hot as that which boils with vehemence.

Boiling point

Stewing is intermediate between boiling and soup-making and is a valuable method of cooking. The meat in small pieces and covered with a little water should be kept at a moderate heat (134° F.+) for a couple of hours. It should be kept constantly moistened in part with its own juices and partly with fresh water, and vegetables may be added. In soup-making all the natural juices flow into the surrounding liquid; in stewing much remains in the meat. The sapidity and hence the acceptability of all food depends in great measure upon the skill of the cook, and this particularly applies to stews. But, pleasant to the taste or not, they are very nutritious, and, whether a stew proper or more nearly a soup, they supply warmth, which is generally, and bulk, which is frequently, desirable, and their prolonged cooking may be supposed to neutralize any bacterial infection. The Warren's Cooker or fireless kitchen, a modification of the Norwegian stove, illustrates how unnecessary and indeed undesirable is the treatment of meat by high temperature and also how fuel and range-space may be economized. In its simplest form there is a wooden box thickly lined with felt. Indeed it may be extemporized by placing one box within another and tightly filling the inter-

Stewing

Fireless kitchen

mediate space with non-conducting material, as sawdust or powdered charcoal. In the middle is a stew-pan with a felt or other non-conducting lid. The contents to be cooked are heated as desired, the pan is placed in the box, which is covered and set aside. In a few hours the work is done with no need of more fire. The chemist's water-bath, or the cabinetmaker's glue-pot, is the type of another excellent cooking apparatus which as a "double kettle" may well be in all garrison kitchens. A thermometer graded beyond 212° F. should be a part of all company kitchen furniture.

Water-bath

Thermometer

Roasting, which in fact is rarely done, requires a large piece of meat to be subjected for a few minutes to intense heat, to shut in the natural fluids, and then to be treated to a dry moderate heat and be constantly basted by the melted fat which exudes. In the field, roasting is effected by cutting the meat into pieces one or two inches square and holding these for a few minutes directly before a hot fire. In the company kitchen baking is the usual substitute for, although it is sometimes misnamed, roasting. Here the treatment is much the same, but it is carried on in a confined oven. In each case the loss is not far from 33 per cent., chiefly of water, the proportion of the chemical elements remaining undisturbed.

Baking meat

In frying, which is the most common form of military cooking, the heat is applied through the medium of fat. Theoretically to fry is to boil in fat, which would be excellent if it could be carried out. But this is never done, because fat cannot boil under ordinary atmospheric pressure, although butyric acid, a fatty acid of butter, may do so when the latter is used. The sputtering which gives the appearance of boiling depends on water in the lard. To fry properly the fat should appear to boil, and that stage is shown by little jets of smoke, not steam, rising from the surface. Slowly heated fat evolves fatty acids, generally injurious, which penetrate and envelop the particles of food

Frying

in grease, rendering them indigestible. The gastric fluids cannot dissolve this, for fat is digested in the intestines, not in the stomach, where it acts as an irritant. The applied heat should be as much above 212° F. as possible.

Bacon

Bacon, which contains much more nitrogen and carbon than fresh pork, is issued at twelve ounces to the ration, in the nature of the case free of bone. It is the exception to the rule that cured meats are less digestible than fresh; its fat is more acceptable than that of pork; it is easily transported; it is well suited as a naturally concentrated food to the requirements of severe exercise; and, taken altogether, it is an excellent military food. Its disadvantages are that it is not acceptable to those not in rude physical health, nor, except as an occasional diet, to most men in hot climates; and sometimes it wastes under natural heat as much as 20–25 per cent. by weight. Bacon that has been slop-fed and summer-cured wastes much more rapidly than corn-fed and winter-cured bacon.

Bacon is best stored in bins with bulk salt in alternate layers. Bacon with very deep layers of fat and thin layers of lean should only be issued at northern stations, for it can neither be carried without waste nor cooked properly in the field, nor be eaten with satisfaction at the south. The proportion of fat is determined by the weight of the sides. Those weighing from twenty-five to fifty pounds are preferable. Where the fat of bacon is yellow and the taste is strong, the meat is rusty or tainted; and when the lean has brown or black spots, it is not good. But bacon from stag hogs or from those fed on mast may be yellowish and still be good.

Salt meats

Salt beef and salt pork are no longer a part of the ration excepting that, when desired, they may be issued in Alaska as substitutes at the rate of twenty-two and sixteen ounces respectively. In the emergency of war, however, these salted meats, notwithstanding they are transported in the field with difficulty and at best are not particularly acceptable, may resume a temporary place in the military dietary. Meat is salted to preserve it, but this is at the expense of the nutritive matters, much of which pass into the brine, leaving only a fictitious value for the solids; so that salt beef is reckoned at two-thirds the value of fresh beef, and this decreases further with age. Salt pork contains much more nitrogen than fresh pork, and under pressure it probably would be issued in a beleaguered place and sometimes in the field at the rate of twelve ounces to the ration. When cooked hard and dry these salted meats become tough and insipid, but vinegar is reputed to soften the hardened muscular fibre. Parkes remarks that as vinegar is an agreeable condiment, it may be important to remember this in time of war.

Vinegar

Canned meat may be issued in garrison when fresh meat cannot be supplied, or in the field as a substitutive ration, at the rate of one pound per ration. This is cooked lean beef in hermetically sealed cans. It may be heated, or subjected to further cooking, before consumption. Canned meat is presumed to contain no chemical preservative, and its freedom from change depends upon the destruction by heat of bacteria originally present and the exclusion by sealing of all others. Carelessness before sealing may admit putrefactive germs. Any alteration in taste or any new odor is a certain sign of retrograde change. Large contracts, especially in war-time, afford temptation and frequently opportunity for the imposition of inferior food of all sorts upon the army; but poor canned meats are particularly to be guarded against, for if they are bad the troops will be ill-fed or will become ill. Further, unnecessary resort to canned meat should be avoided; for experience shows that concentrated food, such as these preserved meats whose bulk is comparatively small, when persistently used are apt to induce intestinal disorder, sometimes as constipation, sometimes as diarrhœa. Bulk seems required to excite the digestion and to stimulate the absorption of nutriment.

Canned meat

Corned beef hash in cans may be issued in garrison when fresh beef is not available, and it is substitutive for fresh beef in the field. The issue is sixteen ounces. Cooked corned beef has double the nutritive value of raw fresh beef, and this issue as hash implies the admixture of vegetables. It is supplied in tins and, while less liable than ordinary canned beef to contamination, precautionary inspection should be vigilant. Good corned beef contains 60 per cent. solids, of which 40 per cent. are proteids, 15 per cent. fat, and 5 per cent. salts. Six per cent. of the whole is nitrogen. Beef is corned by subjecting it to a pickle, and it often happens that in garrison a company can lay down a quantity of corned beef, which makes an economical, wholesome, and very acceptable variety for the company mess. A formula for the process is: For fifty pounds of beef, take two gallons of water and dissolve in it four pounds of salt, one and a half ounces of saltpetre, and a half ounce of salæratus. Boil this solution and, after skimming it, let it cool gradually. When it is quite cold, put the beef under a weight in the brine and leave it there for eight or ten days, when it will be ready to use. Boiling is the proper mode of cooking it. After the brine has been used four times, it must be boiled again and carefully skimmed. This may be repeated three times.

Corned beef hash

Method of corning

Fish dried, pickled, or canned at fourteen, eighteen, or sixteen ounces respectively, substitutive in garrison, is acceptable and nutritious. Dried fish imported from New England has been a staple diet in the West Indies for many years and it has been used in campaign by other armies. Hence, as it is not difficult to transport wherever our troops may serve and is an excellent food, it might well be a substitutive part of our field ration. But the composition of fish is so unstable that when canned its integrity is always open to suspicion. Many tropical fish are poisonous even when freshly caught, so that all fish from those waters are only to be eaten with extreme caution. The Filipino custom of exposing fish to the sun to acquire a new flavor would be hazardous for white men to follow.

Fish

Damaged or diseased meat

Over-driving

Veal and fresh pork

Decaying meat

Sausage and meat pie

Hash

All animals used for food under normal conditions should be sound, properly slaughtered, and free from subsequent contamination, and the flesh should be well cooked. But under stress it sometimes happens that, as a choice of evils, this rule may be suspended. Thus over-driven beasts sometimes develop a toxin, the apparent consequence of excessive heat and fatigue. Foraging and hunting parties, as well as cattle-guards, should be cautioned against such harassing exhaustion of animals driven in or accompanying the army. Veal and fresh pork, even when normal, sometimes cause temporary but disqualifying sickness, but this is not common enough to condemn their occasional use. Decomposing meat should not be used, notwithstanding some savages eat it by preference and without apparent detriment, and "high" game on the tables of epicures acquires its flavor by the taint of decay. Occasionally lost explorers have thus been saved from starvation, but it is a desperate option. Sausages and pies made from apparently wholesome meat may become poisonous, probably by the formation of a ptomaïne not yet identified. The time these articles are kept before consumption is a probable agent in its development. Spices, although disguising the taste, do not antagonize the action. In warm weather hash prepared the night before it is to be eaten is liable to induce colic and diarrhœa. This results from bacterial fermentation probably set up through contaminated vessels. This possibility is another reason for constant and scrupulous cleanliness in the company kitchen, for every effect has a pre-occurring cause. Stale mixed dishes will often act in the same way from incipient decomposition.

Animals which have died, or are suffering from mortal or even from serious diseases, ordinarily would be condemned as a matter of course; but meat from them is not necessarily harmful, and in severe straits it is better to issue such than to

Rinderpest and pleuro-pneumonia

Glanders

Tuberculosis

Milk

Anthrax

Charbon

Medicines

Rules for using diseased animals

allow troops to starve. Thus repeatedly animals ill or dead of the cattle plague (rinderpest) and of epidemic pleuro-pneumonia have been eaten without harm, and as late as 1871 horses dead of glanders were consumed in large numbers during the siege of Paris. How far meat and milk from tuberculous cattle are necessarily dangerous to man is not definitely determined. Meat showing local signs of tuberculosis should not be used, as a matter of precaution as well as of delicacy; but parts not directly affected (as determined by scientific examination) might be passed in time of need. It is so much safer to abstain from the milk of tuberculous cows, whether actually contaminated or not, that it should always be excluded from garrison. Anthrax, or malignant pustule, is so desperate a disease for man as well as for beast, although communicated through abrasions or cuts rather than by the digestive organs, that it should be avoided except in the direst need, notwithstanding there is considerable evidence that such meat has been eaten with impunity after thorough cooking. To avoid infecting other animals the bodies of those dying with malignant pustule (anthrax) should be burned, not buried. To charbon, the same disease in sheep, the same rules apply. It is further to be remembered that although the flesh of animals affected with disease has been eaten without ill effects, it also occasionally happens that persons are poisoned by the stronger medicines with which such animals have been treated. The general rule to follow when the flesh of diseased animals must be used is: Carefully to drain away the blood; to discard the organs, such as the liver, the kidneys and especially the glands; and thoroughly to cook everything that is eaten. Here as elsewhere heat is the great deliverer from infection.

Besides the illnesses just discussed, animals are subject to two parasites which may be transmitted to man through the mess-table, one gravely annoying and the other very serious. These are the tapeworm and the trichina. The tapeworm is the further development of the *cysticercus*, which embeds itself in the muscle of the ox and the hog. It then appears to the naked eye as a small round cyst, which is known popularly as the measle; and when these are numerous the flesh crackles when being cut. Old and musty pork is sometimes described as "measly," which is an incorrect description. The live measle after entering the human intestine with the food develops into tapeworm.

Parasites
Tapeworm

The measle

Trichina

The *trichina spiralis* is a minute parasitic worm frequenting swine, and when swallowed by man it multiplies and causes a very painful and dangerous disease. The *trichinæ* are killed by the heat which coagulates albumen (160° + F.). But if the interior of boiled or roasted pork shows the color of uncooked meat, the albumen has not coagulated and the parasites are unaffected. Some recruits will eat smoked (unboiled) ham by preference when they can obtain it; but common smoking will not kill the parasites. Hot smoking is fatal to them. Hence all doubtful meat should be thoroughly cooked, and the cooking be tested, to insure against these three common evils, tubercle, tapeworm, and trichina.

Horse-flesh

Horse-flesh contains more nitrogen and less carbon and hydrogen than beef. It is a palatable and stimulating food, and in an emergency horses killed in action, or not required in the defence of a closed place, should be utilized.

Emergency preservation

For temporary use in an emergency, meat may be preserved for some time by heating very strongly the outside. This coagulates the albumen in the outer parts and hermetically seals the interior. The application to the surface of charcoal or sugar is also preservative, and black gunpowder well rubbed in would probably have a similar effect. In rainless regions meat cut into long thin strips and dried in the sun, that is "jerked," whether beef or venison, is a good dependence for scouting parties.

XVI

FOOD: THE BREAD COMPONENTS OF THE RATION

Bread

Bread, the other important part of the ration with meat (for practically meat and bread are its essentials), is the only part of the soldier's food in which there is no necessary waste. Every particle of it may be eaten with advantage, and it is one of the few foods that never pall upon the appetite. Nevertheless it is not a perfect diet, being deficient in fat and moderately so in nitrogen; hence butter or other greasy food is eaten with it, as if by instinct.

Gain of weight in bread-making

In making bread there is a gain in weight of one-third over that of the flour used; hence eighteen ounces of flour will yield twenty-four ounces of bread, and so in proportion. At the discretion of the company commander two ounces or less of flour per ration may be used by the company otherwise than for bread. But in garrison the remainder of the flour must be made into bread at the post bakery. The money derived from the sale of the bread or flour, that is the difference in price between the flour received and the bread issued (owing to the gain in weight of bread over flour), constitutes the bakery fund; and after the expenses of the bakery are paid from that fund the remainder is equitably divided quarterly between the organized units. The bread is required to be baked thus at a central plant for economy of administration and for uniformity in quality.

Bakery fund

Subsistence bakeries

In great camps for training or distribution where the commands fluctuate, in camps of more or less permanence in the field, as in winter quarters, the Subsistence department usually erects its own bakeries, in which case the profits, or savings, go to that department and not to the troops. A great camp, or even an army operating along the line of a railroad, may be supplied from a bakery at a secondary base, or sometimes from one at the general base. In minor camps of any permanence portable iron ovens will furnish temporary bakeries, and for marching columns bakery-wagons in which men can knead the dough, and travelling ovens to follow wherever guns can pass, are practicable and have been used. For brigades or less, not permanent camps, the baking as well as the cooking must, as a rule, be done by the companies, as explained later.

Travelling bakeries

The standard ration of flour or of soft bread is eighteen ounces. It is possible, under the concurrent authority of the council of administration and the commanding officer, to increase the bread ration, not the flour ration, at any particular post to the full extent of the allowance of flour or to any part thereof. But when the bread is made and issued by the Subsistence department, no increase over the prescribed weight may be expected. It should be possible so to alter the regulation that, from the subsistence bakeries also, an increased bread ration may be issued in emergencies. The weight of bread is to be taken cold, because it becomes lighter by the evaporation of the contained water. Hence weight for weight cold bread, which is the standard, contains more nutriment than hot bread; and while hot bread is not necessarily indigestible, certainly is not merely because it is hot, if it should be heavy that is less likely to be detected before it becomes cold. That it may have a proper proportion of crust, usually estimated at 30 per cent., the loaf should not be too large; it should be thoroughly baked; the interior should be filled in all its parts with minute cells; and the body of the loaf should be slightly elastic, reacting from gentle pressure. When held in the mouth, there should be no recognizable acidity.

Weight of bread ration

Hot and cold bread

Qualities of good bread

Flour, the essential ingredient of bread, is the crushed kernel of wheat from which the two outer husks have been removed.

It contains from nine to fourteen per cent of nitrogen, chiefly in the gluten, and from sixty to seventy parts carbonaceous matter as starch, dextrin, and sugar. **Flour** The husks or bran contain about fifteen per cent nitrogen, three and five-tenths fat, and five and seven-tenths salts. **Wheat bran** Hence theoretically it is highly nutritious, but practically it is not so because of its indigestibility. Whole flour, so far as it truly contains the bran, is of more than doubtful utility because of its mechanical **Whole flour** irritation of the digestive organs. But the whole flour as advertised usually has little bran remaining in it. "Straight" flour is the whole product of the wheat less the refuse, with a small percentage of the low grades. **Straight flour** A bushel of wheat, sixty pounds, should yield about forty-four pounds of this flour. Although not so attractive to the eye, this moderately dressed or straight flour is the best for issue. "High patent" flour, of which "family" flour is a type, is a very fine, well-milled flour made from **High patent flour** selected wheat. It thus is higher in price and is more attractive in appearance, but it is not as nutritious as "straight" flour. The roller process, by which most flour, probably the whole output of the great mills, is made, does not yield quite as acceptable a product as the grinding by the older buhrstones. Flour is tested by touch, color, taste, odor, and elasticity. **Tests** Formerly the best quality was recognized by absolute smoothness and whiteness; now the rollers do not yield an absolutely impalpable powder but one that is slightly rough, nor is it as adhesive as that made by the older method. **Smoothness** The dark color of the hard winter Turkey and Russian wheat gives such flour a yellowish tinge; nevertheless decided grittiness or excessive yellowness indicates, as it always has, commencing change. **Color** Specks show imperfect milling or very low grade. Whatever the standard, flour must be of uniform color. Good flour is slightly acid to test-paper, but not to the taste; and recognizable acidity indicates change. Acid flour makes sour bread, and a disagreeable taste, or a musty or sour odor, indicates bad flour.

Taste

Boiling water poured over a handful of flour should evolve no other odor than that of freshly ground wheat.

Odor

Damp flour should always be rejected, for it marks an early stage of decay. The gluten of the flour is an important nutritive factor, and its strength or elasticity makes a standard for comparison between different qualities of flour, which inspectors use under the name of the dough test.

Strength of gluten

Dough test

To use the dough test, mix carefully two ounces of flour, with two tablespoonfuls of water, and when the flour is all incorporated shape the mass into a cylinder $1\frac{3}{4}$ inches in diameter by $2\frac{3}{4}$ inches high and stand it on its base. It is evidence of strength if after thirty minutes it has stood up well with a hardened dry surface. If it falls, flattens, or runs over the plate it is a sign of weakness, of inferior milling, or of poor stock. Knead it again carefully, flatten it and pull it out gently, not suddenly, for about five inches. Should it rebound quickly it is evidence of superior gluten. Again knead it gently, flatten it out uniformly to the size of a plate, and then gently and gradually pull it at the edges, until it is very thin, like extended rubber. As far as this may be done without tearing, it shows strength and superior gluten. Failure of the dough test shows weak flour from poor wheat, that is wheat which is sprouted, damaged, or old, or imperfect milling and defective gluten.

Damaged or contaminated flour

Flour from sprouted wheat makes heavy, dark bread. All flour deteriorates with age, but that made from sound, clean winter wheat maintains its character the longest. When it begins to be impaired mites (*acari*) appear, and later small beetles (*weevil*) are present.

Mites and weevil

A single acarus or mite may be found in good flour, but its presence is a suspicious sign that should lead to frequent inspection. These are most common when the flour is damp, and excepting when only a solitary and accidental one may be discovered, it is a sign that the flour is changing.

The weevil is a small beetle, more common in the grain than in the flour, which may be present and multiply in either. It is objectionable in that it consumes the flour and, besides, is an undesirable addition to one's own diet. Munson advises weak fumes of sulphur dioxide (SO_2) to purify a storehouse where such vermin have acquired residence. But the gas will injure exposed flour. As flour readily absorbs odors, sacks of it should never be stored near vegetables, fruits, spices, tobacco, turpentine, coal-oil, etc., and they should be piled in tiers six inches apart, about nine feet high, in a dry room. Flour in well-coopered barrels is less liable to absorb odors or moisture.

Storage

Dough is flour mixed with salt and water, and bread is dough distended throughout its structure by carbon dioxide (CO_2) and cooked. When the yeast is incorporated with the dough at a moderate temperature, fermentation, which depends upon the growth or development of the yeast, commences. This converts a part of the starch into dextrin, lactic acid and a little sugar are formed, and carbon dioxide gas (CO_2) is generated. The gas distends the dough by filling it with aëriform vesicles, when it is said to rise and is called the sponge. Having risen moderately, the sponge is thoroughly kneaded into a homogeneous whole and is set aside for the second rising. It is the presence of the gas which separates the particles of flour and makes the bread light. After it has well risen the second time, the mass is briskly heated but not to excess. The heat coagulates the albumen of the gluten, which thus holds the loaf together; it destroys the rawness of the flour, and it fixes the changes already begun. The uniform diffusion of carbon dioxide through flour and water and the action thereon of heat are the essentials of bread-making. There are three ways of generating the required carbon dioxide, viz.: (1) By the use of yeast or other ferment; (2) by means of a baking-powder, such as sodium or ammonium carbonate mixed dry, added to tartaric, phosphoric, or citric acid; (3) to force the gaseous

Making bread

To develop CO_2

carbon dioxide mechanically through the dough. Of these, the third is probably the best way, because the conversion of starch into dextrin and sugar and the formation of lactic acid are limited; but it requires special apparatus, and is rarely available in the military service. A good baking-powder for extemporaneous service is: Tartaric acid, two ounces; sodium bicarbonate and arrow-root, each three ounces; all to be well mixed and kept perfectly dry in a wide-mouthed bottle. (Yeo.) (The arrow-root has no chemical action, but tends to keep the other ingredients from caking.) Ordinarily, however, a competent commercial baking-powder is issued when properly required for.

Aëration

Baking-powder

Ferment

The first method, that of a ferment, for disengaging carbon dioxide may be called nature's way, but it requires special skill. Where yeast, the ordinary ferment, is not available, leaven may be substituted. Leaven is a lump of fermented dough whose further action has been restrained, laid aside from a previous baking; or it is such a lump kept moderately warm for some time in which fermentation has been revived by the heat. This is kneaded through fresh flour and water. Bread made with leaven is liable to become bitter and as a rule does not keep very long, but it is well adapted to prompt consumption. The better and common garrison method is by using yeast. Ordinarily twenty pounds of flour would require from four to six quarts of tepid water, one or two warm mashed potatoes, a little less than two ounces of salt, and a half pint of liquid yeast. The fermentation is checked at the proper point by the skill of the baker.

Leaven

Yeast

Yeast may be indefinitely perpetuated by a supply carried over from an earlier stock. When liquid yeast is exhausted it may be started afresh by the commercial yeast cake, which can be obtained in nearly all settled regions. In that case mix together four warm mashed boiled potatoes and one cup of sugar, then add one pint of flour and, slowly, one quart of boiling water. When, after having been

Renewal of yeast

well stirred, the mixture is lukewarm add one yeast cake dissolved in warm water. A cupful of this should be kept over in a glass or stone jar from one baking to another, the jar being freshly scalded each time. But if there is no form of yeast, fermentation may be started by mixing a thin batter of flour and water, which should stand in a warm place until it is full of bubbles. This ferment is only about half the strength of yeast. In the field a zealous company cook will carry on the march, in a covered vessel, sufficient yeast for his current need.

Alum

In making bread a little alum, whose action is not well understood, is frequently used empirically. Some suppose that it limits excessive changes; others that it aids in the liberation of carbon dioxide. In the small quantities in which it may be legitimately used alum is harmless; but in excess, as in some baking-powders, it interferes with digestion. Alum is also added sometimes, to fermenting flour so as to check the fermentation and to enable the flour to be used; but this is of very doubtful propriety. Within proper limits, alum is supposed to whiten the bread. Bread may be heavy, that is not be sufficiently dilated with the gas and the gluten unduly adhesive, from various causes; as from bad yeast that ferments too rapidly, when it has fermented insufficiently, or when too great or too little heat is used. It may be bitter from bitter yeast, and it may become mouldy from an excess of water. An efficient baker is a skilled craftsman to be carefully selected and practically appreciated; for spoiled batches of bread waste the bakery fund, harm the men's digestion, and quickly create discontent.

Heaviness

Poor flour

Occasionally flour is found that is poor because the wheat was poor, as when grown on sandy soil or where lime is deficient. Such flour may rise well enough, but it becomes heavy and sour on cooling. When the flour itself is at fault good bread may be made from it by using lime-water. Sometimes acid flour must be used under stress, and this also requires good lime-water. For such use the lime-water must be caustic, made from quick-lime not from air-slaked.

Lime-water

To prepare this, keep a barrel of water in the bottom of which is two ounces of quick-lime. This should be kept well supplied with quick-lime so that it may be active, and it must be stirred up well in time to settle before each demand is made upon it. This use of lime on a large scale corrected the deficiency in great quantities of such flour, in the Washington bakeries in the earlier days of the Civil War. Bread made with yeast from too old stock sometimes becomes heavy and sour, also. Obviously in that case it is necessary to renew the yeast.

Sour and stale bread

Bread sour from an excess of acid becomes edible when the acid is volatilized by toasting the bread in thin slices. Stale bread cut into thick slices may be freshened by toasting, while stale loaves soaked in water and heated in an oven to 250 degrees to 300 degrees F. become fresh. But these must be eaten within twenty-four hours.

Transportation of bread

For transportation, loaves should be laid on their sides or ends and not on their bottoms. The standard army wagon carries 1400 eighteen-ounce rations of bread, and with sideboards 1800.

Every company is supplied with a field oven and a range well adapted for company baking and cooking.

Company oven and range

The weight and cost of the oven are less than those of the Dutch ovens (presently to be mentioned) of equal capacity, and it can be carried wherever there is moderate transportation. But when not in touch with stationary bakeries and where formal field apparatus is not available, there are various devices for the effective use of flour by the company or squad. The more common of these are Dutch ovens, mess-pans, frying-pans, barrel ovens, and holes in the ground.

Dutch oven

The Dutch oven is a heavy flat iron pot with short legs and an iron top which fits within a high flange. It is heated by coals beneath it and heaped on the top. Several of these may be economically used together in a trench to avoid the waste of fuel. The conventional loaf may not be cooked in this contrivance, but a circular flat cake of bread, substantially the same, is very well baked in it. It is also suitable for other forms of cooking when fuel is abundant and there is transportation, for the Dutch oven is heavy and unwieldy. To bake bread in mess-pans: Cut off an inch or an inch and a half of the iron rim of one pan, leaving a rough edge; fill the cut pan two-thirds with dough and invert over it a perfect pan; place these in a hole eighteen or twenty inches deep, in which a fire has burned several hours and from which all the cinders but a bed two or three inches deep have been removed. Cover the pans with hot cinders and then with earth to retain the heat, and let them remain five or six hours. The gases escape over the rough edges of the cut pan and the bread will not rise against the top. To use a frying-pan: Grease it and set it over embers until the grease melts; put in dough, rolled a half inch thick, and return to the fire, shaking it so that the dough may not stick; when the lower crust forms, remove the bread and set it up on edge close to the fire, turning it occasionally. One man with six pans can bake twenty-five pounds of bread in less than an hour. A barrel oven is made by laying a barrel (preferably iron-hooped) with one head out on its side in a hollow. The bottom as it lies is covered inside with well-puddled mud or clay to make a floor. The top and sides are covered with wet clay six to eight inches deep, and this with dry earth for six inches, leaving at the further end a three-inch opening through the casing for a flue. Burn out the staves by a fire made within the barrel, when there should remain an efficient oven to be heated in the usual manner. When the embers are drawn and the bread is put in, the flue must be covered and the front closed to retain the heat. If the barrel can be put into a bank it would be better than building up the oven in the open. Where barrels are not available, the face of an earthen bank may be cut perpendicularly, or a pit may be dug and one side be used as an artificial bank.

Mess-pan

Frying-pan

Barrel oven

Into this may be made a tunnel not to exceed five feet long, half as wide, and one-fourth as high. The entrance should be kept low and not wider than to admit a bake-pan, or it may be filled in to that extent. It is better to arch the interior, and it is necessary to pierce the roof at the further end for a chimney, using lengths of stove-pipe if convenient. The chimney is the most difficult to adjust. It should be heated in the usual way, and the entrance and the flue are to be closed while baking goes on. (Munson.) The simplest of camp methods is to fill with a fire a small hole in the ground, at the bottom of which is a stone, renewing the wood until there are plenty of embers. When the fuel is consumed, place on the stone a mixture of flour, salt, and water, cover this with a tin plate and surround it with hot ashes. If the heat exceeds 212° F. the bread will toughen. This mode of baking closely resembles that for hoe cake or Johnny cake, where corn meal replaces flour.

Bank-oven

Hole-baking

When soft bread or flour cannot be supplied, hard bread at the rate of one pound a day is supplied. This is unfermented dough, with little or no salt, thoroughly baked in thin cakes, usually rectangular. It is the equivalent of ship biscuit or pilot bread. Bulk for bulk it is more nutritious than soft bread on account of the water having been driven off; but like soft bread it is deficient in fat which, when practicable, is instinctively added by the men, who do not thrive on hard bread as a continuous diet. It is most economically issued in very small squares contained in stiff, flat, one-pound cartons, which should always be used in the field. There is then no waste, as occurs with the large biscuits, which crumble when carried loose in the haversack.

Hard bread

Corn meal is a substitute for flour in garrison, at the rate of a pound and a quarter a ration. It is not capable of being baked into loaves, but would be made into pone or corn bread, or occasionally into mush, by the company cooks. Corn meal is very nutritious, containing as much nitrogen and four times as much fat as flour. The best is from

Corn meal

white corn, water-ground (by buhr-stones) and reasonably coarse, and should represent selected, kiln-dried maize and be well bolted. As it is bulkier than flour and cannot be made into biscuit it is unfit for field use. It does not keep well in store, being apt to become sour when in mass and therefore it is not useful as a reserve stock. When not thoroughly cooked corn meal is liable to disagree even with those accustomed to it, and those not accustomed to it are apt to find it so distasteful as almost to require a special education before accepting it. On the other hand, men who have always eaten corn, to the practical exclusion of wheat, sometimes are sickened by the continuous use of flour. The practical lesson is that, where there is any possible choice, newly raised troops should receive their accustomed diet in this particular, so that southern regiments should not be limited to wheat bread nor those from the north be fed with corn meal if it is unacceptable. The emergency, or special, use of dried or parched corn in the grain has a different bearing.

XVII

FOOD: THE VEGETABLE COMPONENTS OF THE RATION AND THEIR MANAGEMENT

Beans

Beans, issued at two and four-tenths ounces per ration (fifteen pounds to the hundred), contain several times as much nitrogen as bread, which they admirably supplement; for their richness in nitrogen makes them a partial substitute for meat. They are both valuable and savory when well cooked, and form an almost daily dish in garrison and a frequent one in the field, as soup, or boiled, or baked. But unless they are well cooked they are indigestible, and therefore are not assimilated and are harmful. Beans require to be soaked in soft water for twelve hours and then to be boiled until they are tender, which will require two or three hours more. Old beans can be softened by no amount of boiling. They must be soaked for twenty-four hours and then be crushed and stewed. Hard water is unsuitable to use with beans, as the mineral salts render the legumen insoluble. When lime-water must be used in cooking beans a certain part of the hardness may be removed by boiling, which precipitates a part of the lime so that if the supernatant water is carefully poured off it may be used. (Pease, formerly issued as a substitute in garrison, have been withdrawn. They are of substantially equal value in nitrogen, but the men care for them only in soup.) Rice, at one and six-tenths ounces per ration (ten pounds to the hundred), is a substitute in both garrison and the field. The principal food of great numbers of Orientals, as seen in our markets it is said to have the greater part of its proteids removed by the polishing it has undergone for the sake of appear-

To boil beans

Beans and hard water

Pease

Rice

ance, and nearly pure starch remains. Properly cooked, so that the grains lie detached, rice is very palatable when eaten with salt and some form of fat; and as its starch is extremely digestible it should be a valuable supplementary food. But boiled into a sticky paste, as is usually the case in company kitchens, it is detestable. To cook rice, sprinkle it into a vessel of salted boiling water so slowly that it will not stop the boiling, and let it cook uncovered fifteen or twenty minutes. It is done when the grains pressed between the fingers are soft. Then drain off all the water, sprinkle it slightly with salt, and set it uncovered in an open oven, or on the back of the range, to dry. The water must boil violently all the time so that the grains are kept separated, and the rice must not be stirred nor cooled while cooking. This is imperative. There should be a large proportion of water and a good deal of salt. Prepared in this way and eaten with gravy or other fat, rice is very acceptable, and pains should be taken to have the cooks learn and follow the proper method. Hominy, the hulled and coarsely broken grains of Indian corn, is a substitute for beans in garrison in the same weight as rice (two and six-tenths ounces per ration). Samp, sometimes called large hominy, has all the qualities of corn meal as a food, but is served as a vegetable. Samp requires soaking in water overnight before cooking. Properly prepared it is delicious and is fattening.

To cook rice

Hominy

The law so far modifies the ration, which is established by the orders of the War Department and not by enactment, as to require one pound of fresh vegetables to be added to it in garrison and in the field. No savings of fresh vegetables may be purchased by the Subsistence department. Of these potatoes are taken as the standard, and a pound and a quarter are to be issued in garrison (in Alaska a pound and a half) and in the field one pound per ration. The substitution of canned potatoes at the rate of fifteen ounces in garrison, twelve in the field, and eighteen in Alaska is permis-

Fresh vegetables

sible, but should not be made when the fresh vegetable is available. For the somewhat complicated conditions under which onions, canned tomatoes, or other fresh vegetables may be substituted, reference must be made to the table.

Potatoes

The average potato contains 154 parts of digestible starch in the thousand, useful to build tissue but not to generate force; a trifle of proteids, thirteen to the thousand; practically no fat; some vegetable acids, in combination as salts with potash, lime and soda; the rest is water. Because poverty made the potato the national diet in Ireland and famine followed the failure of the crop, it has been erroneously looked on as a complete food. On the contrary, a man must consume fifteen and one-half pounds of potatoes daily in the effort to live on them alone, and as a constant diet this involves impossible assimilation. In reasonable amounts the potato is useful to supply starch, but not more so than rice, which contains also from 3 to 7.5 per cent. nitrogeneous matter; it furnishes a certain bulk, which is an aid to digestion; and it has a high sanitary importance through its salts, whose antiscorbutic quality constitutes its real dietary value, especially in the absence of other vegetables. But it is bulky, difficult to keep from deterioration, and ill adapted for transportation, especially in the field. Much of the practical value of the potato depends upon its treatment in the kitchen.

To cook potatoes

For the company mess potatoes should be either boiled or baked, in each case preferably with the skins on to avoid the loss of the salts. When boiled, if old and withered they should be put into cold water, but if fresh and firm into boiling water. To pour many potatoes at once into boiling water will stop its boiling for the time, which is undesirable.

Boiled

They should be of nearly uniform size to secure equality of cooking; or, if they cannot be selected, the smaller ones should be introduced when the others are partly done. If the skins have been taken off before boiling, which is not well, the water should be well salted to resist the outward flow of the vegetable salts, unless the water in which they are boiled is to be served as would be the case with an Irish stew. Then it would be immaterial. It is always better to use some salt in the water, whether the potatoes are peeled or not. A medium potato requires slow boiling for about thirty minutes. Cooked rapidly, especially when already peeled, they absorb water and become soggy, which also happens when boiled too long. Boiled insufficiently they are lumpy and indigestible. When mashed, they should be mashed thoroughly and uniformly, and this should be done while they are still hot. Lumpy mashed potatoes are as disagreeable in the company mess as on an officer's table, and as unnecessary. Baked potatoes should be cooked in the oven or, on the march, in hot ashes, until soft as determined by pressure, not by sticking a fork into them. For the potatoes to be well cooked, not merely to be cooked, should be a matter of pride, evidence of superiority. In this, as in other points of domestic economy, the intelligent criticism and encouragement, not the indiscreet interference, of the company officers can accomplish a great deal. When the art of cooking is once acquired in a company kitchen, every man of the organization should learn it practically. The militia should be taught in squads, eating what they prepare in requital or retribution as the case may be. Onions, a partial substitute for the potato ration, are always acceptable in the field and usually in garrison, whether boiled, fried, or raw. Besides being grateful to the taste of most persons engaged in outdoor life, there is frequently a marked craving for this vegetable, which has a wide and well-deserved reputation as an antiscorbutic. It contains the acetic, citric, and phosphoric radicals combined with lime, potash, soda, and magnesia, and it holds a stimulant volatile oil which is driven off by heat. As is true for other vegetables, the onion is more efficient as an antiscorbutic when raw than when cooked, and fortunately it is very acceptable thus. Like potatoes, onions

Mashed

Baked

Teaching cooking

Onions

suffer from the frost in severe weather, so that their storage requires much care. They may be issued in garrison as a substitute for an equal weight of potatoes, not exceeding 20 per cent. of the whole; and in the field only when procured locally, the difficulty of transportation being prohibitive. The equivalent of 20 per cent. of the potato ration may also be issued in canned tomatoes, in either garrison or the field. The tomato is excessively watery, some specimens as canned containing 97.6 per cent. fluid, and on that account it fills a small place as nutriment. But raw or cooked, tomatoes satisfy an instinctive desire for a vegetable acid, which grows stronger as other vegetables become scarcer. The probable explanation is that it contains three-tenths of one per cent. of free malic acid, and about as much more combined with bases. Owing to this the tomato ranks with, or, in the opinion of some, higher than, the potato as an antiscorbutic. The substantial reduction of the fluid without lessening the malic acid should be an interesting problem in dietetics, for, when solved, the canned tomato might be even more freely issued at a very low cost when really fresh vegetables are difficult to obtain. When other fresh, not canned, vegetables can be obtained near by or be transported in good condition from a distance, they may be issued in garrison in lieu of an equal quantity of potatoes but not to exceed 30 per cent. of the allowance of potatoes. That this is not permissible in the field, depends upon administrative difficulties. Fresh vegetables frequently are most desirable there, and military ingenuity should open an equitable way by which commanders of units could procure them for their men; but it would be impracticable for a department to furnish a variety of vegetables on a summer campaign, and in winter camps the best for the purpose are already provided. It is to be remembered that all vegetables at all edible have a sanitary value by virtue of their contained salts, however trifling their energy-making or tissue-building qualities. Prunes, with dried or evaporated apples

Tomatoes

Other fresh vegetables

Prunes, apples, peaches

or peaches as substitutes, all at the rate of 1.28 ounces per ration (8 pounds to the hundred), are issued in garrison. Their effect is more toward furnishing those influences which aid digestion than directly to increase strength or bulk. When possible 30 per cent. of the whole must be prunes. None of these are supplied in the field, although prunes may be transported without special difficulty. Jam may be supplied in garrison in lieu of an equal quantity of prunes, but not in excess of 50 per cent. of the whole issue, the 30 per cent. of prunes always being required when available. The constant object is to insure the direct influence of this preserved fruit upon health. Jam, which is a combination of three parts of sugar to four of fruits, is a fixed component of the field ration, with no substitute, at 1.4 ounces (8¾ pounds to the hundred). The value of the sugar will be taken up later.

Jam

Vegetables in general

Shrinkage in cooking

In addition to their special value as antiscorbutics, sound fresh vegetables are always desirable for their own sake as food, as affording variety to the table, as giving zest to the appetite, and as a probable aid to digestion and to the assimilation of other food. Besides the waste in preparation, which varies with the article, there is an average shrinkage of 10 per cent. in cooking vegetables. In tropical countries and at special stations unusual precautions, to be noted later, must be observed in handling all vegetable products that are eaten raw and with some that are not.

XVIII

FOOD: THE SMALL PARTS OF THE RATION

For convenience, coffee and tea, the official artificial beverages of the troops, will be discussed together and water will be taken up later.

Coffee and tea

The ration of coffee, roasted and ground, both in garrison and in the field, is 1.12 ounces (7 pounds to the hundred) and that of tea, which is substitutive, is .32 ounce (2 pounds to the hundred). In garrison coffee roasted, but not ground, may be issued at the same rate, or green at 1.4 ounces ($8\frac{3}{4}$ pounds to the hundred). Coffee is best made by the ground roasted berry being boiled for one or two minutes and standing in infusion for five minutes. In soldiers' hands the ground coffee and the water are thoroughly boiled together for a considerable time. This dissipates much of the aroma and perhaps drives off part of the active principle, but when sufficiently prolonged it has the sanitary advantage, which in the field is inestimable, of insuring immunity from bacterial infection through the water. The more freshly and more finely ground the berry, the more fragrant and probably the more efficient the beverage; but in garrison sometimes the grounds are used the second time and sometimes chicory and coffee "extracts," harmless adulterants, are added. These please an uncultivated taste and save money for the company fund. They should not be allowed in the field, where it is important to secure the entire physiological effect of the coffee. In campaign the men must make their coffee in individual tin cups, and the roasted and ground berry is liable to loss and damage while carried upon the person.

Coffee making

Coffee is a gentle nervous stimulant, practically without reaction, useful in winter by the warmth it yields and in summer as it replaces perspiration. It accelerates and at first strengthens the heart's action and the respiration, and it probably increases instead of, as has been supposed, retarding tissue change. Its especial value lies in the resistance it offers to the effects of fatigue and cold, increased by the volume of hot water in which it is usually taken. In this, both immediately and permanently, it far exceeds any good to be derived from alcohol. The abuse of coffee, leading to extreme nervous irritability, is a very remote contingency with troops, by whom it is rarely taken strong enough for such an effect and whose physical exercise may be trusted to counteract that mischief. To be deprived of his coffee is always one of the most serious misfortunes for an American soldier.

Physiological effects

Tea, the substitutive ration, has practically the same physiological effect as coffee, but its advocates hold that this is displayed more pleasantly and more persistently. It has an advantage in being less in bulk and lighter in weight, although if it comes into common use the size of the ration should be nearly trebled. Notwithstanding its attractiveness when properly made, tea has never been popular with the mass of American men (although those working in the lumber camps make great use of it), a practical point to be considered when a volunteer army is raised. Moreover, dependence upon milk for use with tea, which is common although really superfluous and incompatible, would complicate the question of supply, as sugar, which also would be demanded, already does with coffee. Properly made tea is an infusion of the dried leaves in water that has been freshly boiled. The vessel in which the infusion is made should be well scalded before the leaves are put in. The process requires only a few minutes and then the tea is ready for use and would better be poured into another heated vessel. But water that contains lime or iron requires to be boiled for fifteen or twenty minutes with a little sodium carbonate before pouring on the leaves. Ignorant people are apt

Tea

Tea making

to boil, or stew, the leaves, and those with vitiated or undeveloped taste to sophisticate it with a deluge of milk. Neither is legitimate. When drawn too long, as a false economy sometimes attempts to extract the utmost strength, repulsive bitterness is developed. Leaves once drawn should not be used a second time. Tea is best drawn in scrupulously clean **Utensils** earthenware, a material not adapted for the field and whose vessels are seldom capacious enough for garrison use. If the vessel is tin there must be no exposed iron, or the taste will be disagreeably astringent. On campaign every man makes his tea individually, for which the ideal cup, now tin, would be aluminum. When tea leaves are carried upon the person, they should have a water-proof covering, **Care of tea** and the most convenient method is in a strong flat glass vial securely corked. Some experienced soldiers habitually carry a private emergency supply in that manner. When long exposed to the air, especially to a damp atmosphere, tea may become air-drawn. There are two classes of tea, black and green, derived from the same plants, **Black and green tea** whose differential characteristics depend upon the action of dry heat. Of these, the black is the more wholesome. There are also many grades of tea, discrimination between which requires an expert and in whose delivery imposition seems easy. The tannin of the leaf, objectionable when excessive, assists in clarifying some unacceptable water; and, as in coffee making, to boil the water sterilizes it. It is to **Sterilization** this sterilization of their water-supply, by its conversion into tea as the habitual beverage, that some observers attribute the remarkable exemption from typhoid fever of the contending armies in Manchuria in 1904. There is much testimony from all parts of the world as to its value in the field, and it is contended by those who have used both tea and coffee under prolonged strain, that tea sustains the physical and mental power far longer and more effectually than coffee and without appreciable reaction. A peculiar and positive advantage of tea is that it is palatable even when highly diluted and when it is cold, which is not the case with coffee, so that under all circumstances it is an acceptable beverage in the field.

Sugar

Syrup, jam

Glucose

Sugar is a part of the ration, both garrison and field, at the rate of 3.2 ounces per day (20 pounds to the hundred). In garrison all of this passes through the hands of the cook, but in the field it becomes a personal issue, made for several days at a time, chiefly to be used with the coffee (or tea), although the man may eat it at pleasure. Issued in the granulated form, it should be carried in a small water-proof case within the haversack to avoid waste. Besides the sugar, there is issued in garrison .32 gill (one gallon to the hundred) of cane syrup. Further, in garrison jam .64 ounce per man (4 pounds to the hundred) *may* be issued as a substitute for prunes; but in the field 1.4 ounces per man (8¾ pounds to the hundred) is part of the formal allowance. Exclusive of the fruit, three-fourths of the jam is sugar. A soldier therefore receives as a part of his food more than a quarter of a pound of sugar daily. That this does not entirely supply the requirements a few weeks after the campaign has opened, is seen by the eagerness with which additional saccharine food is then consumed. Science now admits that sugar produces energy, as well as creates muscle and fat. This has long been practically recognized in civil life by the extensive use of molasses on farms and in lumber-camps, and of molasses and water as a sustaining beverage in the haying-field. The comparatively recent demonstration on a large scale, by the British troops in South Africa and by our own men in the Philippines, of the place of sugar in the field should be appreciated, and the Subsistence department should be prepared to make special gratuitous issues of it or to sell candy to the troops at cost price. Sugar as part of the ration is cane sugar. Glucose, transformed from starch, is an adulteration, not harmful, as sometimes supposed, but inferior, and is to be inspected against by purchasing officers.

Milk

The ration, both garrison and field, also contains a half ounce of unsweetened, evaporated milk (3⅛ pounds to the hundred), excellent when honestly made, but hardly more than a luxury. Unsweetened milk is said not to keep well after the can is opened.

Vinegar

Vinegar is issued at .16 gill (2 quarts to the hundred) in garrison and in the field. Cucumber pickles may be substituted for one-half, or less, of this in quantity. Vinegar, of which the pickle may be regarded as a convenient form, has been immemorially a part of military subsistence. The Romans drank it diluted with water on the march, and an ingenious explanation of Hannibal's splitting the Alpine rocks with vinegar is that he maintained the vigor of his troops in those barren solitudes by its free use in their diet. To be dietetically valuable, vinegar must be the product of true acetic fermentation and not merely depend upon a mineral acid for its sourness. Acetic acid, the normal constituent, is valuable, and sulphuric acid, the most common adulteration, is hurtful to the body. The latter should be constantly inspected against.

Salt and pepper

Salt at .64 ounce (4 pounds to the hundred) and black pepper at .04 ounce (¼ pound to the hundred) are supplied alike in garrison and in the field. Salt is indispensable and cannot be omitted for any length of time. Pepper is desirable but not essential.

Condiments

Cinnamon, cloves, ginger, and nutmeg, interchangeable substitutes for each other at .014 ounce per man (1.4 ounces per hundred), are attractive condiments in garrison, not furnished in the field. In the same class is the flavoring extract of lemon or of vanilla, .014 ounce per ration.

Lard

Lard, used in frying, as an ingredient in some foods, for application to the interior of utensils in cooking, and generally where grease is required in the kitchen, is issued at .64 ounce per man (4 pounds to the hundred) in garrison, not in the field.

Butter and oleomargarine

Butter at .5 ounce per ration (3⅛ pounds per hundred), or oleomargarine, substitutive at the same rate, supplies in garrison at least part of the fat in which bread is deficient and which every diet requires. Difficulty of transportation denies it to the field. The margarine preparations with different designations are nutritious forms of fat, which should not be objected to under their own names on the company mess-table.

Profusion of the ration

Field ration

Importance of cooking

Duty of officers

The articles enumerated for posts are supplemented on occasion by nearly every food obtainable in the local markets, through exchange or purchase. Possibly the very abundance and variety of the garrison ration are injudicious by bringing into unpleasant contrast the field ration, which is adequate and toward his subsistence upon which the training of the soldier should be constantly directed. It may indeed be a question whether the field ration itself is not liable, through its weight and comparative complexity, to be impossible of supply when most required. These are subjects for serious consideration. However they are decided, his ability to cook his rations properly and without waste is a marked feature in the efficiency of the trained soldier over the volunteer, and indeed of active over sedentary regiments. Raw commands invariably break down in the preparation of food, and over and over again state troops on riot service have gone to pieces from inability to feed themselves in the midst of plenty. The ability to cook is not intuitive, so that the practical use of the ration is one of the first lessons to be carefully taught; for whenever the stomach is not properly supplied the man is inefficient. No labor is better expended on the soldier than instruction in cooking for himself and in squads. Fire discipline has its foundation in healthful vigor, and the Subsistence department may lavish its stores in vain if they do not reach the soldier in an assimilable form. Superintendence of the men's cooking is required of the line as well as of the medical corps (R. S. 1174, 1234). This does not mean that they should instruct in minute detail, but that they themselves should understand the general principles and see that they are followed. Because in peace the National Guard has so little time for camp life, it is the more important that enough of that little time should be devoted to this necessary care. After they can cook the ration properly, recruits may pass out of this stage, but until they can do this they will simply masquerade as soldiers. On the other hand, the company or the regiment that can best prepare the regular ration, not some fanciful and costly variation thereof, will be the one which first will reach and longest hold its position in the field. It should be quite legitimate for such troops in their practice camp to employ a number of competent civilians, or old soldiers, as instructors, not as their cooks. That service should stand at the very head of all the duties in such a camp or in one of concentration. Among seasoned soldiers the recruits learn through absorption by contact. In the permanent service, upon which the remainder should be modelled, that captain whose intelligent enthusiasm has embraced the interests of the company mess will have the most willing and usually the most dependable company behind him. In garrison, messes of more than one organized company should not be allowed. They relieve company officers of direct responsibility for the welfare of their men in this respect, and interfere with the dissemination of practical knowledge among individual soldiers. Garrison messes would foster ignorance of one of those very conditions upon whose exercise success in the field depends.

National Guard

Army

Garrison messes

XIX

FOOD: CANNED FOODS; UNOFFICIAL FOODS; DIETETIC DISEASES; ALCOHOL; TOBACCO

Canned food

Gas

Flux

Much excellent food is supplied in tins, a state well suited for preservation. But because it cannot be directly observed before issue, special care is necessary in inspection when originally packed and also while in store. Formerly, doubtful goods having a fictitious factory name and no dealer's name were freely marketed. First-class canned food carried both the true name of the factory and that of the wholesale house through which they were sold. The poorer goods might thus easily be avoided in peace, but under the pressure of war they might be foisted upon the army. The Pure Food laws make the risk of substitution much less now, but it still is important critically to observe the filling of great contracts where there is constant temptation to debasement. Canned food kept long in stock, especially under either extreme of temperature, may deteriorate; and sometimes fermentation occurs because the original quality was poor or there has been access of air. If gentle tapping gives a hollow sound there has been fermentation. This is still more evident if one or both ends bulge. Two sealing-holes no longer imply that the gas of fermentation has been allowed to escape through a new vent which afterward was closed; for some companies habitually use two holes in their original packing. But an occasional can with double holes means inferior contents. A flux of zinc chloride, sometimes used, is charged with being harmful to health, although this has not been proved. The older rosin flux is a harmless seal, for at the worst the rosin when carelessly used merely affects the taste. The best fastening

Trade weight

Shape

is with a flange, as commonly used with French goods. The true weight and the nominal weight of canned goods rarely agree, and the contents of certain trade packages are officially estimated thus: 1-pound can baked beans, $10\frac{1}{8}$ ounces; 3-pound can, $34\frac{1}{2}$ ounces; $2\frac{1}{2}$ pounds tomatoes, 2 pounds; 3-pound can, $2\frac{1}{4}$ pounds; gallon can, $6\frac{3}{4}$ pounds. This should be remembered when drawing stores in bulk. It would seem that cans might pack to greater advantage and be carried more comfortably upon the person (when thus required) if they were rectangular and relatively flat instead of being, as commonly, circular in section.

Oatmeal

Cheese

Composition

Digestibility

There are other foods of varying degrees of acceptability sometimes added to the mess from the company fund, liable occasionally to be supplied by order in emergency. Thus, oatmeal carefully cooked is very nutritious, developing weight for weight 130 foot-tons of potential energy against 87.5 by bread. It keeps fairly well, but in a tropical climate packages once opened must be used rapidly. It is easily cooked and, while it lacks adhesiveness for making large loaves, small flat cakes can be preserved. It is rich in protein and fat and is good military food. As a hot or cold gruel it is extensively and profitably used by laborers on hard work, and it is strongly recommended as an extra issue for men on guard at night or on heavy fatigue. Oatmeal porridge is a capital occasional dish for the company table in garrison. Cheese was formerly but is no longer issued to travelling troops, at four ounces to the ration (25 pounds to the hundred). It is nutritious and economical, being rich in nitrogen and in fat. A half pound of cheese contains as much proteid as one pound of meat and a third of a pound as much fat. The combination of bread and cheese, or of hard bread and cheese, makes an almost ideal diet. The common opinion that cheese is necessarily indigestible is not well founded, for when carefully masticated it is readily acted upon by the digestive fluids; but it certainly is less easily assimilated than properly cooked flesh, so that it is better as an occasional than as a standard diet. The "ripening" that cheeses undergo is a bacterial action. The richer cheeses decompose rapidly, and all are liable to do so in hot climates. Hence, although economical as actual food, cheese is wasteful as accumulated stock. An obscure fermentative (bacterial) change sometimes develops an active gastro-intestinal poison (tyrotoxicon) in cheese that presents no visible sign of change. This may be detected by pressing against the cheese a strip of blue litmus paper, which will suddenly become red. Boiling water dissipates the tyrotoxicon, so that the affected cheese may be safely eaten after having been cooked. "Margarine cheese" is a legitimate artificial product in which other fat is substituted for that of milk. Mushrooms are an agreeable addition to the company table when they are grown naturally and are eaten fresh. Their nutritive value has probably been overrated, but they are acceptable for flavor and as variety. Under favorable conditions they are readily cultivated; but as other fungi which closely resemble them are very poisonous, every doubtful specimen should be discarded. An edible mushroom should peel easily, be a clear pink, and have a curtain attached to the stalk. The bad reputation of tropical fruits depends in great part upon careless selection. They should be fresh, sound, and scrupulously clean. It is in staleness, commencing decomposition, and contamination that danger lies. Salads and other raw food grown on or near the surface of the ground, as radishes, melons, and some berries, are especially liable to receive bacterial or parasitic contamination and to convey such infection. This risk is not limited to the tropics but exists wherever sewage-fed gardens send their produce to market. It is greater in the tropics because of the widespread fæcal pollution of the soil and water and the more favorable conditions for bacterial growth. When freed from such risk

Decomposition

Tyrotoxicon

Margarine

Mushrooms

Tropical fruit

Raw vegetables

by careful selection and effective cleansing, tropical fruits and vegetables should be refreshing and wholesome. Dried corn mixed with sugar or mesquit-flour is extensively used in Mexico and along that frontier; and this might well be issued to scouts or native irregulars for field service. It is not suited for regular troops except as an emergency substitute. But a Mexican Indian runner will travel long distances when eating only parched corn and sugar, and sometimes a little dried beef, and drinking only water.

Pinole

Occasionally men are fed through the company fund with food of a cheaper grade than the regular issues. As a rule, which has exceptions, such food is inferior as well as cheaper. The Pure Food laws fairly protect against adulterations, but speaking generally it is not economical to buy food that costs much less than that supplied by the Subsistence department.

Cheap food

A disease which formerly ravaged armies and always appeared among sailors on prolonged voyages was scurvy; and this reappears to-day under favorable conditions. It is not due to infection and hence does not pass from man to man, but its common cause leads to widespread disability. Scurvy is essentially a change in the composition of the blood from the lack of certain necessary constituents in the food. This is now so well understood that arctic and other explorers, who else would suffer, are able to guard against scurvy for years together. Its prevention is one of the most successful applications of sanitary science. The essential cause of scurvy is probably a reduction in the alkalinity of the blood, due to the lack of the neutral salts of the organic acids found in the food, generally associated with a want of fresh vegetables. As Notter and Firth also observe, the prolonged consumption of preserved food, animal and vegetable, is so associated with outbreaks of scurvy that it would seem due to a "devitalization" from faulty preservation, not to bacterial or putrefactive decomposition. These conditions are supplemental, not opposing. Scurvy may be

Scurvy

Cause

superinduced by mental depression. Not that mental depression of itself will cause scurvy, but when the diet is unfit the dejection that follows defeat or is due to unhappy conditions may precipitate an outbreak. Scurvy is checked by cheerful surroundings, but they alone are insufficient to relieve it. Conversely it not only disheartens the men, whose dash lessens and whose fortitude gives way, but its earlier symptoms simulate other distinct diseases. Company officers are not to regard scurvy as obsolete, something that disappeared with percussion caps and smooth-bore muskets, and when they learn that many of their men are complaining of "chronic rheumatism," the soldier's designation for indiscriminate and multiple aches, or of stiffness of the muscles, and particularly if there should be a case or two of night blindness, they should look into the company mess. Scurvy is checked by the use of fresh vegetables, vegetable acids, or their vegetable salts. The habitual use of raw or underdone flesh is remedial or preventive, and Munson suggests that cooking splits up the organic acids upon which this power depends. Pemmican is a particularly nutritious antiscorbutic in great vogue in arctic regions. Lime juice and lemon juice are effective as preventives and as remedies, and are well adapted for use on shipboard. In general terms fresh succulent fruits and vegetables fill the need, but scurvy is not apt to occur where they are found. Of these the seeds have little value and the legumes none at all. Of the generally available the raw potato, the raw onion, and the raw tomato are the best. Cabbage is good, fresh cabbage being better than sauerkraut. Cider vinegar is very useful, and so are yellow mustard and the cresses eaten raw, lamb's-quarter and dandelion leaves as a salad or boiled as greens, and the young shoots of the poke-berry served as a vegetable. Raw potato, peeled and sliced and covered in layers with molasses, is an excellent antiscorbutic that keeps well and hence is available in the winter. The cactus, whose numerous varieties are widely distributed over the plains of the West and South, contains a

Mental influences

Treatment

succulent interior excellent for this purpose. The rough covering must first be stripped, sometimes by the aid of fire. The tall kinds of cactus supply valuable juice when tapped. The best of all antiscorbutics is the *agave americana* (the century plant). It is prepared by cutting off the fleshy leaves close to the root, cooking them in hot ashes, and expressing the juice. This should be drunk, raw or sweetened, at the rate of from one to four wineglassfuls three times a day. It is not only preventive but actively curative. The white interior of the leaves may be eaten with advantage.

Beri-beri

Another disease to which food-supply is supposed to bear a causative relation, liable to affect large numbers of men, is beri-beri. This practically concerns the army only as touching its Oriental dependents; but beri-beri has scourged Filipino prisoners so terribly that a caution is necessary against confusing that which happens with that which must happen. Locality is also believed to be a contributing factor so far as to require the evacuation, at least temporarily, of the camp, barrack, or prison in which the epidemic appears. This disease is technically a form of neuritis which is constantly present in most subtropical countries, and its victims are principally among the rice-eating peoples, but its precise cause has not been scientifically demonstrated. The Japanese navy, which it formerly ravaged, has been practically freed from it by a liberal increase in the ration, which was made on a theory of nitrogen-starvation. But during the recent Russian war the army was more liberally fed than at home and nevertheless suffered greatly. It seems probable that once having arisen, whatever the exact cause, succeeding cases are rapidly infected and that the locality becomes charged with the active agent. Sanitation rather than clinical medicine is required to limit its progress. It is necessary to fortify those within its influence with a diet better in kind and greater in amount, to remove them from a damp locality, and to magnify the area and the cubic space at their disposal. Notter and Firth, acting on reports from the

Malay States, give credit to Fletcher's contention that those who live on "uncured" rice may contract the disease while those who subsist on the "cured" variety are exempt. The cured rice has been boiled before it is stored, and they suggest as possible that an infective parasite may have been killed, or an essential poison in the rice have been destroyed by the heat, as the alternative of supposing that the cured rice is richer than the uncured in the proteids. The white races seem to have a substantial but not absolute immunity to beri-beri.

Alcohol

As food

Amount of work

Quality of work

Action on the brain

Alcohol in the form of whiskey was once a part of the ration, and later it has been an occasional issue. Now it is only supplied through the medical department. It is, however, sometimes suggested to be desirable after exposure, and there is a contention that its moderate habitual use in tropical countries would be beneficial. It may unhesitatingly be affirmed that under normal physical conditions alcohol is never necessary and usually is undesirable. Academically considered, alcohol may be regarded as a food when taken in very small quantities. But it is by no means the best food, and beyond exceedingly narrow limits it acts so anomalously upon the nervous system in health that it is impossible to consume enough to be of nutritious importance. The food value of alcohol for any effective purpose may therefore be dismissed as nil. In moderate amounts alcohol temporarily increases the power for muscular work, but this is so promptly succeeded by enervation that in about half an hour the work falls below the average and succeeding doses do not renew the force. The sum total of work done with alcohol is less than that done without it. The quality as well as the quantity of work done is diminished, even after very moderate indulgence, as is demonstrable in typesetting, in marksmanship, and in such methodical exertion as simple marching. This is strikingly evident at the target-range, and would be still more conspicuous under the conditions of war. The action of alcohol upon the nervous system is primarily due to its influence upon the brain, which is noticeably affected by four-tenths of one part per thousand parts (.0004) of body-weight. That is, a trifle over half a pint of wine containing ten per cent. of alcohol will induce in a person of average weight cerebral changes sufficiently obvious to be studied. That would be the equivalent of one pint of five per cent. beer, or of rather less than two tablespoonfuls of forty-five per cent. whiskey or brandy. The so-called, or presumed, excitement induced by alcohol is really a more or less incoördination of the psychical qualities. It is essentially an anæsthetic which relaxes in an increasing ratio the restraints of reason and judgment. It is this relaxation of restraint rather than a true stimulation which leads first to cheerfulness and then through gayety to the hilarity of conviviality, an hilarity so liable to transcend propriety and to degenerate into violence or to be lost in stupor. In

Effect upon temperature

small quantities alcohol exercises no influence on the temperature of a healthy adult; medium quantities lower it a little; large quantities cause a fall of several degrees, extending over several hours. The sense of warmth that certainly is felt after drinking a small quantity of alcohol is not due to any increase of bodily heat, but to the dilatation of the small blood-vessels of the stomach and skin through which more of the warm blood of the interior is brought into contact with the sensory nerves. These register the heat-impression which depends upon the transfer, not upon the increment, of the agent. The lowering of the bodily temperature by alcohol increases the danger of freezing while intoxicated, which is so notorious in the severer climates. Such positive reduction of the vital warmth destroys resistance to the outer cold, and the narcotic action of the alcohol substitutes insensibility and helplessness for the alertness necessary to overcome the prostration.

General influence

The experience of large commands all over the world and under all conditions of heat, cold, and exposure has been uniform that health and efficiency are greater when no spirits are used. In garrison, in camp,

Spirit-drinking

Beer-drinking

with working parties, on forced marches, on outpost service, to say nothing of battle itself, small quantities have no influence, and the moment its effect is recognized alcohol is hurtful. Taken habitually even in really small quantities, alcohol leads slowly to morbid changes in all parts of the body, which become permanent; and on this account its daily "moderate" use is more dangerous to the health of the consumer than are periodical debauches. Once the habit of moderate drinking is acquired, the demand for alcohol steadily increases, so that the entire avoidance of spirits is always the safer and to many is the easier course. Even in small amounts, alcohol disturbs muscular action, alters the disposition, and deranges the judgment; hence, independently of the disease it may induce, the untrustworthiness of the intemperate and the serious consequences of their action and their inaction are sufficient reasons for discouraging its use in military life. As maintained by Binz, "the habit of taking alcoholic stimulants apart from meals is a public evil from a sanitary, economic, and intellectual point of view." What is true, in this way, of civil life is doubly true of the military service, where clear judgment and swift decision are required of the leaders and prompt coördinate action of the subordinates. A high moral duty rests upon officers not to mislead their commissioned juniors through their own example, nor to set a pattern which the rank and file would be swift to follow. Further, alcoholics exhibit increasing liability to disease through greater risks and lowered resistance, and they usually suffer a severer type of the graver constitutional affections. A man who drinks beer to excess is always a nuisance, although not so actively as the spirit-drinker. Beer-drinkers become gross in body without being vigorous; besides its visible redundance, they accumulate fat where it is apt to be harmful, as between the muscular fibres of the heart; they are inclined to be mentally slow and stupid, and, although not quarrelsome or violent, their efficiency is distinctly lessened. Nevertheless many if not most recruits are moderate beer-drinkers before enlistment, and as beer-drinking is much less subversive of discipline than is spirit-drinking, and particularly as spirit-drinking out of garrison is a fruitful cause of disorder and leads directly to incidental disease and often to indiscipline, a well-regulated Post Exchange, wherein malt liquor may be sold under supervision, promotes essential temperance and military efficiency by decreasing the temptation to drinking, with its incidental excesses, beyond the lines. A voluntarily abstinent army would be most desirable; but that is not yet attainable, and the best present substitute is one content with the regulated and moderate use of beer in garrison. On taking the field no alcoholic beverage of any sort should accompany the troops and no vender of drinks under any name be tolerated, for upon the slightest opportunity spirits would be smuggled within the lines, to the impairment of health and the detriment of discipline. The administration of alcohol in disease is entirely distinct from its use as a beverage in health, and is a question of therapeutics, not of hygiene. The consumption of a teaspoonful or less of diluted alcohol by famished explorers in danger of freezing appears to have saved such starving and exhausted men from immediate death. Such use is distinctly medicinal, the oxidation of the contained hydrocarbons apparently supplying enough heat and perhaps energy temporarily to prolong life. Such use requires skill and much caution to avoid more harm. Of the more common spirituous drinks, whiskey contains from 41.5 to 52.15 per cent. of alcohol, brandy about 48.37 per cent., and American beer about 5 per cent., all by volume.

Exchange

Medicine

Composition

A crudely distilled spirit is found in the Philippines under the common name of "vino," which the natives drink in very small quantities and with extreme moderation. When taken by the whites as they would whiskey, it is baneful and it frequently induces acute temporary but violent mania. The persistent use of vino wrecks the cerebral

Vino

centres, so that the men should have its character distinctly explained by the company as well as by the medical officers. Absinthe, a peculiarly poisonous liqueur, less liable to be taken by the men than by officers, at first after a dinner and later by itself for its own sake, contains from forty-seven to eighty per cent. of alcohol and the aromatic principles of wormwood and other plants. Its special poison is due to these aromatics. Absinthe induces epileptic attacks as well as delirium, sometimes in succession, sometimes one and not both. Unlike alcohol itself it very soon occasions hallucinations and it quickly and completely destroys its victims' nervous system. To drink absinthe is a military offence in the French army. Wood (methylic) alcohol, derived from the destructive distillation of wood and extensively used in the arts, is acutely and often fatally poisonous when drunk, as it sometimes is under misapprehension. Every vessel that contains it should be plainly marked "Poison," and its nature should be made a subject of instruction, for fatal accidents frequently occur from ignorance.

Absinthe

Wood alcohol

The Subsistence department sells tobacco at cost to soldiers. Because it materially disarranges and impairs nervous action, tobacco is very detrimental to the young, particularly when its active principle (nicotine) is absorbed through the inhalation of the smoke. After tolerance has been established, tobacco is a frequent solace to the adult and it seems to diminish molecular waste. On this account soldiers already accustomed to it may use it with advantage when on hard marches with limited food. But this exceptional benefit does not compensate for the physical drawbacks that mark the acquisition and in many cases the practice of the habit.

Tobacco

XX

SOILS AND SITES

Soil

In its hygienic relations soil is that portion of the earth's crust that may affect health. Besides the ordinary mineral basis, it may include vegetable and occasionally animal remains and, except in the most compact rocks, air always and water usually is found in the interstices. It is the character of the soil much more than what is popularly called "the air of the place" which determines the healthfulness of a locality.

Permeability

For purposes of residence soils are roughly divided into permeable and impermeable. The impermeable are weathered granite, trap and metamorphic rocks, the various hard limestones, clay slate and dense clay, impermeability referring to the barrier presented to the passage of water and permeability to the possible movement of water through the substance of the soil. The permeable soils are the chalks, sandstones, sands, and vegetable moulds. Of these average sandstone absorbs about twenty-five per cent. and ordinary mould from sixty to seventy-five per cent. of rainfall. Obviously, where water may pass air and similar gases will also be present and will more freely move. The air

Soil-air

within the soil is generally rich in carbon dioxide (CO_2), and may be charged with more noxious gases and with effluvia from organic decomposition. The proportion of CO_2, the result of chemical disintegration of more complex bodies, has been found at a depth of thirteen feet below the surface to range from 26.3 to 54.5 volumes per 1000 of

Motion of soil-air

the contained air, and the soil-air with all its gaseous contaminations is constantly in motion laterally and vertically. These movements of the soil-air are due to changes of temperature in the soil and to the effect of rain.

The fluctuations which the rain, locally or at a distance, makes in the ground-water alter the position of the soil-air, displacing first that which is superficial and later the deeper air. The direction of that movement always depends upon the degree of resistance encountered. A more common cause of subsoil air currents is change of temperature, either seasonal or artificial. The looser the soil the more freely and the further the air may travel through it; and when the surface is consolidated, as by freezing or when it is closely paved, the gaseous elements may traverse long lateral distances. They move under the pressure of rising ground-water; in the effort to equalize their density with that of the atmosphere; by the *vis a tergo* from a ruptured conduit, as a gas main; or by being drawn toward the partial vacuum created by the rarefaction of adjacent air. Thus the upward draught of air in a heated dwelling attracts the soil-air (ground-air) into the cellar, which acts as a flue to carry it into the house. Every winter fatal cases of gas-poisoning occur in cities among the poor where the illuminant makes its way from fractured street mains beneath but parallel to the surface, escaping into basement sleeping-rooms. The gases of decay when set free in such a soil follow a similar course. Such possibilities are always to be remembered when men are hutted on the ground, as in winter camps, or married quarters are unwisely placed; for air from cesspools, broken drains, and buried decomposing matter may pass laterally and escape upward through the earthen floor or into a cellar. Dug-outs, or the excavation of tent floors for the sake of warmth, should be tolerated only in wholesome and perfectly dry soil, and all permanent habitations, particularly on sandy ground, should be cemented below the surface level or be built on arches.

Subterranean currents

Dug-outs

Besides air, soils contain water, divided into soil-moisture and ground-water. The soil is moist when it contains air as well as water; but ground-water fills the interstices to the exclusion of air, so that there is a continuous sheet of water excepting as its particles are separated by solid portions of the soil. **Water in the soil** Soil-moisture is derived in part from the rainfall, when its amount depends upon the quantity of rain and upon the ability of the soil to absorb and retain it. **Soil-moisture** It also depends in part upon evaporation and the capillary action that follows the changing ground-water level, being more appreciable in the upper soil when the ground-water is high. This dampness of the upper soil, by its absorption into the walls of habitations may render their atmosphere chill and humid. **Influence on health** It affects health by furthering the decomposition of organic matter lying in the ground and by predisposing to and aggravating catarrhal, rheumatic, and neuralgic affections and by promoting tuberculosis. A damp house is invariably an unwholesome house. **In bivouac** Therefore when compelled to bivouac upon damp ground — and most ground is damp in relation to the body — there should be either a water-proof sheet interposed between the person and the ground or, better, the man should lie on some slight elevation of boughs, boards, rails, or even stones, which would remove him from direct contact and by preference afford an underlying air-space. The discomfort is trifling in comparison with health. A large command not in a wooded country cannot thus supply itself, when it is more important for blankets or extra wraps to be under than over the body. The health of animals as well as of men may be affected by redundant soil-moisture. **With stables** A striking illustration of this is the case of two stables exactly alike excepting that in one the ground-water was two and a half feet and in the other between five and six feet from the surface. The horses received identical care, but in the one with the excess of soil-moisture there was constant sickness while in the other there was none. Equal health was attained by merely draining the damper soil.

The ground-water or subsoil-water, the water-level of the engineers, is a subterranean sheet lying at different depths according to the locality, from two or three to hundreds of feet below the surface, not necessarily horizontal, in constant motion generally toward the nearest watercourse, with changing level and varying flow, and affected by such obstacles as rock dykes, the roots of trees, deep wells, and low drains. As a general rule a high groundwater is insalubrious for those who live over it, and lowering its level as little as two feet has been known to make unhealthful sites innocuous. The soil may be made drier by diverting the inflow, by opening the outflow, or by deep drainage. It sometimes happens that the afflux of water from higher ground fills an otherwise desirable site with a flow that cannot escape freely. The soil becomes water-sodden. An intercepting drain or a diversion of the surplus water by auxiliary drains will give partial relief. Opening the natural exits and adding to them will give the detained water opportunity to escape. In other cases direct drainage by the introduction of tile drains at a sufficient depth will keep the level sufficiently low. It is the province of sanitation to point out what is required and, when desired, to explain the reasons; but its execution is a matter of engineering.

Ground-water

To lower ground-water

A permanent post would rarely be demanded upon a water-soaked site, but a camp of investment or one of observation may be forced into such a situation. Sanitary drainage would add more to the capacity of the situation than equal labor expended upon more ostensibly defensive works. The substitution of quick-lime and ashes for a few inches of the surface soil in a damp post is of advantage as a desiccant over limited areas where the destruction of vegetation is of no consequence. As a matter of intelligent sanitary precaution newly established posts on all but the most impermeable soils should be underdrained from eight to ten feet deep in lines ten to twenty feet apart. In the extreme south deep underdraining should be carried out even in apparently sandy soils. Tiles once properly laid are practically indestructible. To lay them the bed

Wet camps

Under-drainage

should be hollowed in undisturbed soil by the workmen resting their feet on a berm ten or twelve inches from the bottom. A fall of one in a hundred is sufficient, and with good workmanship one in two hundred is enough. With a grade of less than one in a hundred or with a poor foundation, the work should begin at the upper end, but with a greater grade at the outlet. Subsoil drainage is effected by laying small-calibre tiles with minute spaces between the lengths, which are covered with earthern collars or, as devised by Waring, with a thin muslin band. This prevents earth from falling in before it packs. The free water enters the gaps from the bottom, thus establishing a new water-level to which the water in the soil recedes as rapidly as the water at that level drains away. The water does not descend into the tiles but it rises to them, as they offer a channel for its escape from the pressure of the water above. Once well established, such a system need never be disturbed. The unenclosed drains of broken stone act on the same principle, but are more apt to become occluded.

As a source of water-supply ground-water will be discussed later.

Impermeable sites

Granite, metamorphic and trap rocks and impermeable clay slates are usually dry and healthful sites, but with all these there may be a scanty supply of drinking-water. Limestone is generally dry and acceptable and the water is apt to be hard, clear and sparkling. Limestone is very liable to contain communicating rifts, sometimes miles in length, through which contaminations may pass to the drinking-water. In limestone ranges marshes at great elevations are not uncommon, due to the retention of water and vegetable and other debris in the broken surfaces which characterize that formation. A wet and unwholesome site due to a high ground-water, although superficially dry, may be found in very elevated mountain valleys which collect and retain the rainfall and melted snow from dominating peaks. Fort Lewis, now discontinued, was a conspicuous example of selection with no attention to the

Limestone

subsoil conditions. Permeable sandstones, the air and soil being dry, are very salubrious; but shallow sandstone underlaid by clay may be damp. Deep gravels not lower than the general surface are always desirable, and the very best sites are gravel hillocks. Clay and deep alluvial soils generally are suspicious. Clay holds water so that the air over it usually is damp. The alluvials contain vegetable matter and are liable to have impermeable strata intermixed. Deep pure sand, free from organic matter, is wholesome. But sands that are lived upon soon become charged with refuse whose gases and liquids may pass through them laterally as well as perpendicularly for long distances. Some sands have vegetable debris intermixed, undesirable in decomposition; and others have water held within a few feet of the surface by underlying clay. Such a combination obviously is bad. Made sites, especially near towns, represent refuse which frequently is impure, and always should be avoided for camps or cantonments. The minimum time for the dissolution of organic refuse is three years, and even after complete decomposition occurs such situations should be avoided. In the vicinity of a post well-cultivated territory is usually healthful, the exception being paddy-fields. The cultivation of rice should not be tolerated near military reservations, partly because of their frequent flooding and consequent dampness but chiefly from being breeding-places for mosquitoes, the agents of malaria. Shifting sands, which often are an annoyance on reservations, may be fixed in the warmer climates, where they are chiefly found, by growing upon them Bermuda grass or lupine.

Sandstones and gravel

Clay

Sand

Made sites

Vicinity of posts

Sands

Deleterious situations independently of soils are enclosed valleys, ravines or the mouths of long ravines, ill-drained ground, in warm climates the neighborhood of marshes, particularly if the wind would carry mosquitoes from them to the post, and the northern slope of

Sites apart from soils

mountains. On sanitary grounds an enclosed valley is objectionable, as interfering with free ventilation on a large scale **Enclosed valley** and as concentrating and retaining drainage. Through ravines there will probably be an air current in one direction by day and reversed at night, **Ravines** leading to abrupt changes of temperature, often to local humidity, and sometimes to an invasion of disease-causing insects with the out-current. But these are insufficient to interfere with establishing a defensive post near the mouth of a pass. Proximity to marshes, especially at their level, is undesirable; to be in the course of prevailing **Marshes** winds from them may be disastrous. In the warmer latitudes military posts near streams should be on the windward, which in this country is usually the southern, bank. When military considerations allow a choice, the southern is much more desirable than the northern side of a mountain or high hill, for protection **Mountain** against cold winds and for a wider range of light. From a sanitary point of view the best situation for a post is a lower divide or saddle-back, unless too much exposed or without water. One almost as good **Divide** is near the top of a slope. But no site, whatever its altitude, unless thoroughly drained is acceptable if dominated by surrounding heights. Military requirements sometimes lead posts to be established at con- **Extreme elevation** siderable elevations. At moderate altitudes health is generally more vigorous than at the sea level, but continued residence at 10,000 feet or above is found to occasion nervous irritability sufficient to interfere with harmonious discipline. At such posts the garrison should be changed at least once in two years. In the barren regions of the southwest a camp is sometimes pitched, and indeed a **Oasis in a desert** post occasionally established, upon a verdant oasis, because it is attractive to the eye. There is verdure because there is also high ground-water, which opens a risk of sickness.

Herbage

In its relation to sites vegetation is divided into herbage, brushwood, and trees. By herbage is meant grass and vegetation which perishes annually. Closely lying grass is always healthful, but, as just noted, on otherwise arid plains localized verdure indicates a damp and hence an unwholesome site. All herbage should be kept closely trimmed, and weeds are not to be tolerated. They usually grow luxuriantly and they present constant temptation for the concealment of broken property, sometimes of garbage itself, that should be systematically destroyed. Fortunately frequent cutting destroys weeds and benefits grass. If weeds attain full growth about a permanent post they should be cut down and burned before decaying. But it is better not to remove primitive vegetation about a merely temporary camp, chiefly from the additional labor it imposes and the risk of developing hollows to hold water. If the camp persists, the herbage should be cut or trampled flat for a broad belt around its borders; and for a prolonged stay everything is to be cleared away.

Brush near marshes

Belts of brush, tall shrubs, and dense herbage about a marsh or stagnant water check the flight of malaria-bearing insects, and in this way protect residents in the vicinity. Roads to water cut through heavy growths and woods sometimes open a passage for mosquitoes that otherwise are barred.

Forests

Forests in both cold and hot countries keep the ground cooler and more moist than it would be if bare. By obstructing the sun's rays they prevent the soil from becoming heated, and the tree roots detain water that otherwise would rapidly run off. The terrestrial evaporation is lessened, but that from the trees perceptibly lowers the atmospheric temperature. In cold countries forests break cold winds, and in hot countries they cool the ground itself, and they may protect against currents of insect-infected air, although sometimes dense vegetation so intercepts the air's course that it becomes stagnant. In the tropics, while shade should be preserved, the forest should not be allowed to grow too dense around military habitations. Besides its well-known effect on floods and water-supply, denudation of forest land makes the extremes of temperature more marked, but there is a general rise. Where trees cut off sunlight and air from a domicile and make it dark and damp they do harm, but they should be removed only with judgment; and in establishing a permanent post no more trees should be removed than are absolutely necessary, until time shows which can be spared. Beautiful parade-grounds have been desolated from the presumed necessity of a drill whose normal development is individual initiative with every advantage of cover. Some officers from imperfect knowledge dread making camp in the woods, and always select open fields when available. To be scorched by the summer sun and torn by the winter storm are equally hurtful. The Romans habitually encamped under trees and, with consideration of the character of the forest, their example is generally good. All vegetation extracts water from the ground and finally evaporates it through the leaves, thus drying the soil. An oak evaporates more than eight times the precipitation that occurs under the spread of its foliage; the eucalyptus, which grows only in frostless climates, evaporates eleven times the rainfall; and, according to Stockbridge, one acre of sunflowers exhales during the growing period, the prodigious amount of more than twelve and a half millions of pounds of water. In this way moist regions may be effectively drained and made unfit for mosquitoes to breed in. Besides its efficiency in diminishing soil-moisture, the eucalyptus is so repugnant to the mosquito that the insect will not approach it, and it affords a perfect refuge from that pest as a bivouac.

Trees

Camps in the woods

Evaporation through foliage

Sunflower, eucalyptus, mosquitoes

As a summary of the more important features relating to permanent sites, these points may be remembered: Avoid soil-moisture in excess, ground-water from decomposing organic matter, prevailing winds that bear mosquitoes, exces-

Summary as to sites

sive elevation, and unnecessary exposure to extremes of temperature. Drain deeply except in impermeable rock; carry off storm-water; clear away brush, except about marshes; if practicable cultivate grass and keep it short over adjacent ground; remove trees only after careful consideration; make the ground actually built upon proof against invasion by air or water, or, in warm climates, raise the houses on piers; and remove all refuse that may pollute the soil.

XXI

BARRACKS AND QUARTERS: CONSTRUCTION

Foundation drains

For sanitary reasons no military post should stand near the base of a hill, on account of the course of the subsoil water; and where a barrack has higher ground behind it there should be trenches deeper than the foundation to protect it from the water under the surface making its way to a lower level that otherwise would be intercepted and held by the cellar wall. These trenches well filled with loose stones form blind drains to conduct the water to a lower point of escape. Indeed, in all cases it is better to lay such drains immediately around but lower than the foundation, and this especially if the soil be clayey or charged with springs.

Foundation walls

Foundation walls below ground should be laid in mortar of cement and sand and be smooth on both faces. It is an error to build cellar walls directly against the side of the excavation (although it may cost less), and a space outside the wall should be filled with coarse gravel. This will lead rain that strikes the house wall, and particularly water that soaks through the ground, downward into the drain at the foot or into the lower soil, as the case may be. When cellar walls are laid dry or are slightly "pointed" on the inside the stonework is liable to dislocation by freezing, with the risk that the water will pass through. Sandstone, soft limestone, and brick absorb water freely, and when either is used a coat of melted tar should be applied to the outer side below the surface and a damp-proof course of lead or other non-conductor be carefully introduced above the level of the ground to check the rise of moisture through capillary attraction. A source of dampness often overlooked is the rebound of rain water from the eaves splashing against the foot of walls. On that account absorbent dwelling walls should be water-proofed exteriorly for a couple of feet above ground. In theory everywhere, and certainly always in damp localities, the cellar floors should be made proof against rising moisture by well-puddled clay or concrete. Common cement is neither gas-tight nor water-tight under moderate pressure, and where a water-soaked locality is built upon, as sometimes must be, the hydrostatic pressure acting upon the sub-cellar water is considerable. Where there are no cellars, the surface under the floors should be impervious and there should be enough clear space between the floor and the ground for efficient policing. All these requirements are frequently omitted under the plea of economy, but company officers should be familiar with them and remember their importance when barracks are reputed unhealthy. When not built of perforated or hollow brick, or double with an intervening air-chamber, house walls should be furred for the sake of the non-conducting air-space as well as plastered, all to avoid dampness. Common stone and brick are very absorbent, and unless intercepted, moisture from rain passes directly through, making the rooms damp and cold. With thin walls of any material the interior is warm in summer and cold in winter.

Cellar floors

House walls

In rainless regions very comfortable houses that are warm in winter and cool in summer are made of sun-dried brick (adobe). Their walls are necessarily very thick and they should be coated with mud plaster. The roof has a broad overhang on account of possible showers. Where worn by occasional storm they are easily repaired. In a heavily wooded country the log house, best square-hewn, is superior to one of sawed timber, which is quite sure to be unseasoned and full of crevices. For provisional quarters, which often outlive their original purpose, the cheap balloon-frame is hastily thrown up. Permanent barracks should not be wooden. Brick, usually costly at first, is the cheapest in the end, always provided that additional quarters are built when

Adobe

Wood

Brick

the garrison is to be increased, so that more men are not crowded into the already appropriated space. A satisfactory barrack for really temporary use in moderate climates is the miscalled pavilion. This is a one-story rough wooden building quartering a company or half-company. The floor is near, but does not rest upon, the ground. It has numerous windows, at least four doors, and in winter ridge ventilation. Pavilions are provisional quarters for camps of rendezvous when tentage is unobtainable or inapplicable. In the tropics bamboo and nipa make comfortable tentative barracks. These are neither costly nor durable, and when the permanent occupation of a post is determined they should give way to brick, stone, or cement blocks. In earthquake regions the construction should be of wood. In bamboo quarters care is to be taken to prevent the entrance of water into the natural compartments of the joints, which otherwise would afford domestic breeding-places for the mosquito. Tropical barracks should not have flat roofs, unless they are double with an ample intervening air-space. All barracks in hot climates, at home or abroad, should be raised on piers sufficiently for the free circulation of air beneath, and they should have very broad verandas on all sides.

Pavilion

Tropical barracks

Besides occupying healthful sites and constructed of proper material, the essential conditions of barracks are dryness, warmth, light, floor-space, and air-supply. Casemates are necessarily dark and generally are damp and ill-ventilated. That they are unfit for permanent occupation is shown by the much higher sick-list they always present. The better permanent barracks are of two stories (except in the tropics, where one is preferable), and the squad-rooms should always be on the second floor, which is less liable to invasion by mosquitoes. Barrack stairways should be wide as well as multiple, with broad steps and moderate risers. Barrack buildings must always be arranged to receive free access of light and air on all sides. That is, one

Essential conditions

Two stories

building should on no account cast its shadow upon another, except possibly at an end of the day, nor intercept a free supply of air. There is no good reason for preserving the primitive and traditional hollow square in the arrangement of individual buildings. These must be placed with due regard to military convenience for assembly and drill, but their relation to sunlight and the prevailing winds should be such as to secure the utmost advantage of each. Parkes advises the long axis of barracks to be north and south, so that the sun may fall on both sides of the building; but when our simpler buildings face the south the sunlight sufficiently floods the squad-rooms and they are swept by the southerly winds. At least no sleeping-room should be so situated that it cannot be thus purified. A southern exposure is not only warmer in winter but, on account of the prevailing winds, at least in the interior, is cooler in summer. When for want of space barracks must be placed somewhat in column, the arrangement should be *en échelon.* But within permanent defensive works sanitary preferences must sometimes yield to military necessities; nevertheless the larger forts can usually concede both requirements, if they are recognized in season. The more elaborate buildings for the larger garrisons should be planned by competent architects, not mere draughtsmen; and these architects should be well acquainted with the peculiarities and requirements of military occupation. Once planned, the specifications should be followed in detail and changes after acceptance and occupation should be made only when authorized by competent authority after their importance is recognized. But however well planned, no squad-room should receive more than its sanitary number of occupants. That number together with the available cubic feet should be conspicuously painted upon the door. There is a constant temptation to overcrowd, to make a military, not a sanitary, unit the measure of capacity, and to assign a company or a half-company as such, instead of a fixed number of men, to an apartment,

Light and air

Elaborate buildings

Capacity of squad-room

forgetting that when a company's quota is increased by order the dormitory is not correspondingly elastic. It is better to assign surplus men to cots on verandas, or to some other chamber, than even temporarily to violate that sanitary rule. Besides, emergency violations make an easy road to habitual evasion.

Officers' quarters

Officers' quarters should face nearly south, or should have as much of such an exposure as possible; and when two sets are, unfortunately, under one roof, they should not face east or west if it may be avoided; for then the northerly set will be relatively cold in winter and uncomfortable in summer. In planning the larger non-defensive posts, or cantonments, intra-communication will be facilitated and the course of the winds be favorably modified by qualifying the formal checker-board system of roads by the introduction of a proportion of diagonal and curvilinear routes. (This is particularly desirable in planning new towns likely to grow, where officers' advice occasionally is asked.)

Large posts

XXII

BARRACKS AND QUARTERS: AIR AND ITS CONTAMINATION

Space necessary

Men at rest within doors, equally with those in active exercise on the drill-ground or elsewhere, require more space than the few cubic feet occupied by their bodies, because they are alive. They cannot be stacked like arms nor piled like balls. The fact is familiar, but the essential reason is not always recognized. We know, historically, that when 146 men were confined over-night at Calcutta in an enclosure 18 feet square with two small windows, 123 died before morning, and that the majority of the 23 survivors soon perished from fever. Still, each person thus incarcerated had two and a third feet standing-room, and a man's health would not be impaired should he stand out of doors in a hot night on a block no larger. Health depends more upon the quality of the air we breathe than upon the character of the food we eat, and that quality rapidly deteriorates after respiration when not renewed. If a man were enclosed in an air-tight receptacle, no matter how capacious, he would ultimately die. This would not be through suffocation in the stricter sense, but through the increasing contamination of the air to whose use he was limited and the final exhaustion of its vital quality.

Fatal crowding

Air

Air is a mixture of twenty-one parts of oxygen (O), the vital agent, and seventy-nine of nitrogen (N), the diluent, practically one to four. It also carries from one-two-hundredth to one-sixtieth of its bulk of watery vapor, and it contains normally four parts of carbon dioxide (CO_2) in ten thousand (.0004) and traces of argon and helium. When one inspires air, oxygen, which is essential for the very act of living, passes out of it into the blood directly through the walls of the capillary blood-vessels, which cover both sides of hundreds of square feet of the delicate membrane that makes up the lungs, where it is taken up by the red corpuscles that float in the current. **Respiration** At the same time and in the same way (by osmosis) carbon dioxide (CO_2) escapes from the blood into the air. This carbon dioxide is a product of the physiological disintegration of the animal tissues, which is one of the evidences of life. The cessation of molecular activity is death. In its passage from the blood the carbon dioxide is accompanied by watery vapor and sometimes by foul gases from waste too long retained, so that in this way the body is in part freed from its own dross but at the expense of vitiating the surrounding atmosphere. **Contamination** Besides this contamination through the mere act of breathing, the air also receives from the surface of the body waste held in solution by the perspiration, dead particles of worn-out skin, and volatile organic matters inclusive, at times, of those from decaying teeth and other ill-kept organs. When invalids are present, as in a hospital, the ratio of contamination is vastly increased, particularly by the pathogenetic output of communicable disease. It is, moreover, evident that every inspiration actually withdraws from the general stock and consumes a specific amount of oxygen independently of that contaminated and rendered less available by expiration. **Oxygen consumed** It is to be accepted as an ultimate fact that animal tissues must constantly receive, through the blood, oxygen from the atmosphere for incorporation with them, and there must be a corresponding release of carbon dioxide from the blood, or death will occur, of which a prompt and complete demonstration is the act of strangling. When the renewal of oxygen stops life ceases. As the available air becomes increasingly debased, although its original volume may not be diminished, its oxygen is in part replaced and in part polluted by these and other impurities, and in proportion as these reënter or for the first time reach the blood an equal amount of oxygen is excluded and, as important, the vital functions are depressed until illness or death ensues. The most easily recognized of these impurities is the carbon dioxide (CO_2), and it is unnecessary for the purposes of dormitory sanitation to determine whether this is itself poisonous or its presence in a squad-room is simply an index of other impurities.

Carbon dioxide

Warm-blooded animals immersed in carbon dioxide gas become unconscious, but they revive after removal not too long delayed. Air may be breathed with impunity when it contains many times the normal amount of carbon dioxide, as at certain baths and bottling establishments where it reaches 150 parts in 10,000. It is probable that a man who loses his life by plunging into a reservoir of carbon dioxide, as a deep well or other pit in which there are no directly poisonous gases, is simply drowned as he would be in water, by the exclusion of air from his lungs. The discomfort that persons endure in crowded ill-ventilated rooms is said not to be due to excess of carbon dioxide, to bacteria, nor as a rule to dust, but to overheating and to disagreeable odors. (Bergey, Mitchell and Billings.) The musty odor there is probably due to the volatile products of the mouth and skin. On the other hand Arloing holds an unconfirmed belief that he has secured a highly poisonous agent from human sweat, which will help to account for some of the very depressing consequences associated with crowds in confined spaces under high temperature, with the air saturated with aqueous vapor. But it is very doubtful whether disagreeable smells as such directly cause disease, although, as Harrington suggests, they may depress the general health of those unaccustomed to them by diminishing the appetite. But an avoidable offensive smell, if only a warning of some other condition, is not to be tolerated in a habitation. On the other hand it is strenuously contended that "the immediate dangers from breathing air

Crowded rooms

Sweat-poison

Smells

highly vitiated by respiration arise from the excess of carbonic acid [CO_2] and deficiency of oxidation and not from any special poison." (Haldane and Smith.)

However all this may be, the recognized increase in disease and mortality among those living in crowded and unventilated apartments is probably due to the depraved and unrefreshed atmosphere lessening the general vitality and weakening the bactericidal powers resident in the upper air-passages. Consequently as such rooms are specially apt to accumulate germ-laden dust, their debilitated occupants are very liable to be infected with and to succumb to pneumonia and tuberculous diseases of the lungs. Such lodgings now are to be found only in civil life, but where they do exist they show what dense occupancy and want of care would as surely lead to among troops. In fact where repeated cases of sore throat occur in barracks deficient air-space and imperfect ventilation may always be suspected.

Close and dusty rooms

Besides gradual deterioration in health, there are conspicuous instances of acute poisoning by positively foul air combined with the lack of fresh air. For instance, besides the notorious Black Hole of Calcutta, already cited, there are the cases of the steamer *Londonderry*, where 72 out of 200 died while confined in a small cabin, and of the 300 Austrian prisoners held in a very small cellar after Austerlitz, of whom 260 died "in a short time." The military lesson here is the obvious one concerning prisoners of war. Not that such prisoners are likely to be thus closely packed at our hands, but that they should not be overlooked even temporarily, and their necessities for reasonable air and exercise should always be considered. It is also to be remembered that horses transported in unventilated cars have been killed under precisely similar conditions. Other examples of the poisoning of man by man are the fever of the slave-ships, the camp fever and the jail fever of former times but always ready to reappear, the immigrant fever of the Irish packets

Effects of overcrowding

Prisoners

Horses

Crowd poisoning

and the typhus of to-day, doubtless associated with specific causes but fostered and intensified by direct overcrowding and want of ventilation. But these very grave conditions are not often met with now. What is usually found is deficient nutrition, leading at first to anæmia or impoverished blood, then to loss of vigor, and then to general diminution of resistance to disease. In barracks, with which here we are chiefly concerned, commonly the direct consequences of the presence of a number of occupants are obvious, but they should not be strikingly so; sewer-air and other direct poisons, carbon monoxide (CO) excluded, are rare; contagious diseases except in the very first stage are seldom found. But in hospitals the emanations from diseased bodies are constantly present and require to be neutralized and diluted or removed.

Conditions in barracks

Hospitals

From the preceding it follows that the less pure oxygen there is available for inspiration and the more the air to be inspired is already clogged with waste products, by so much the fundamental physiological functions that depend on normal respiration are impaired. Hence a prime duty of those having the care of men is to make sure that they have an abundance of unpolluted air to breathe. Now, it is a frequent but not a necessary concomitant of civilization, that the inmates of ordinary habitations — and this applies to officers as well as to the enlisted men — may suffer from the diminution of the respirable quality of the air by the increase of carbon dioxide in it and the presence of depressing emanations from human bodies; gases, more or less poisonous, products of combustion; the compounds, sometimes odorless and sometimes giving out smell, collectively known as sewer-air; and those invisible particulate emanations, unrecognized except by their results, that cause the infective diseases.

Officers' duty

Insanitary dwellings

The constant and inevitable contamination of dormitory air is carbon dioxide. In repose a healthy man breathes about fifteen times a minute, somewhat less frequently when sleep-

Carbon dioxide

Watery vapor

Contamination by heating

Contamination through lighting

ing profoundly, a little oftener when actively employed. He takes into his lungs about two-thirds of a pint of air at a time and the air once breathed loses five per cent. of its oxygen and gains a little more than five per cent. of carbon dioxide. This is at the rate of six-tenths of a cubic foot an hour, or from twelve to sixteen feet in the twenty-four hours. A man also discharges from his lungs and skin in the course of the day from twenty-five to forty ounces of water, which requires about two hundred and ten cubic feet of air per hour to maintain as vapor. Besides the fresh air that is consumed and that which is altered by the act of respiration, much air may be consumed and objectionable compounds thrown into the apartment by the combustion of fuel. These products are usually conducted into the outer air through flues, and of course they are not found in rooms heated by steam or hot-water coils, and they should not be in the hot air supplied through registers. But where stoves are used in the sleeping-rooms there is some risk, and furnaces occasionally leak gas into the air pipes. The combustion of gas, oil, or candles to furnish light also vitiates the air. Every foot of ordinary illuminating gas when burned produces half a cubic foot of carbon dioxide, and each burner gives out from three to six feet of gas per hour, depending upon its form, and therefore throws into the atmosphere from one and a half to three feet of this product hourly. To dilute it properly, every foot of CO_2 requires one thousand feet of fresh air. Every pound of mineral oil that is burned requires eight thousand feet of air for its dilution. Candles yield still more carbon dioxide in proportion to the light they supply. Expressed in terms of persons, for every 16-candle power kerosene vitiates as much air as seven adults; an ordinary gas burner as much as five adults; a Welsbach burner as much as three. Electricity as an illuminant has no influence upon the constitution of the air.

Besides the carbon dioxide (CO_2), a very dangerous carbon

Carbon monoxide

compound, carbon monoxide (CO), sometimes escapes into occupied apartments. Carbon monoxide is actively poisonous in that it changes the blood by rendering the red corpuscles incapable of carrying the vitalizing oxygen through the body. Of it "less than a quarter of one per cent. by volume in the air will cause poisoning, and but one per cent. is rapidly fatal to animal life." (Harrington.) An excess of carbon dioxide inspired replaces oxygen and also prevents a sufficient release of that which forms in the blood, but the victim usually will recover when pure air is substituted for the impure. That is the case with carbon dioxide, but carbon monoxide so alters the physical character of the blood that it cannot take up the oxygen even when the sufferer is supplied with fresh air. The blue flame given off when coal is freshly supplied to a stove indicates the generation of CO. Carbon monoxide is entirely inodorous, and thus so much the more dangerous because it is recognized only by its effects. It has the peculiar faculty of passing freely through red-hot cast iron as well as the ordinary one of leaking from the joints of stoves, so that the primitive heating apparatus in temporary buildings may be fertile in its supply. This is the fatal agent in the fumes from burning charcoal, where it is given off abundantly.

Acetylene gas and water-gas

Both water-gas and acetylene gas are very rich in carbon monoxide and are correspondingly dangerous if there is any leakage from the fixtures. One part of acetelyne gas to 12 of air is explosive. Carbon monoxide accompanies, but in much less degree, the ordinary illuminating coal-gas, with which it may escape through imperfect joints, and it is additionally generated when the combustion is imperfect. It also is liberated in the imperfect combustion of mineral oil. Much gas escapes from cracked mains, and, as already noted, this is liable to drift under the frozen or tightly paved surface into cellars, where sometimes death results.

It has been explained that the normal proportion of carbon dioxide in the atmosphere is 4 parts in 10,000. Now should there be no accidental source of pure carbon dioxide—and ordinarily there is none in barracks—all in excess of this is derived from respiration, and it is called "the carbonic impurity." But just as the proportion rises so do the other impurities from living bodies increase, consequently the amount of carbonic impurity is an index of contamination, and it is chiefly as such index that this excess has a sanitary value. The danger of living in ill-ventilated rooms whose carbonic impurity is high is much more serious than would follow inhaling merely a proportion of carbon dioxide equivalent to that expired. Within reasonable limits the carbonic impurity, like the headlight on a locomotive, is not itself dangerous but it is a warning of danger to those within its influence; and as a moderate excess over the normal must be found in every inhabited apartment, this is designated up to six or seven parts as "the allowable impurity." When the impurity is greater than 6 or 7 parts in 10,000 it is usually a sign that the contamination is combined with the other conditions that make up crowd poisoning. Excessive combustion of oil or gas in an ill-ventilated and sparsely inhabited room might lead to an excess of carbonic impurity without implying crowd poisoning; but by the exercise of ordinary judgment officers, for whom this work is prepared, could determine the essential condition without elaborate analysis. In fact to distinguish between the carbon dioxide developed in respiration and that generated by combustion would probably require a chemical or other accurate knowledge of the associated compounds, and would be of no practical value under ordinary garrison conditions.

Carbonic impurity

The most convenient practical test to determine overcrowding, or insufficient ventilation in the presence of living bodies, that in the last reduction yield the same result, which may be called "vital impurity," is the normal sense of smell. A "close" or "musty" to say nothing

Vital impurity

of an offensive smell betrays the presence of this depressing aërial poison and means harm. To one entering from a stay in the outer air the recognition of any odor indicates six parts of carbon dioxide to ten thousand, including that which is normally present. Carbon dioxide is not odorous, but experience shows that the two additional parts imply the presence of other perceptible contaminations. A very oppressive odor means more than twelve parts of carbon dioxide and its concomitants to ten thousand of air, and this is independent of the products of combustion (which of course debase the quality of air for breathing) and refers only to animal emanations. The simplest chemical determination of the relative amount of carbon dioxide present in the air, one that any company officer can operate, is Smith's lime-water test. As condensed from Munson, it is arranged thus: Six clean well-stoppered bottles, ranging from 100 to 450 c.c. capacity, filled with distilled water, have the air to be examined introduced by pumping with a small bulb-syringe or by pouring out the water. From a bottle of clear fresh lime-water 15 c.c. are introduced by a pipette into the smallest bottle of air. This is then closed and vigorously shaken. If turbidity occurs, there are at least sixteen parts of carbon dioxide in ten thousand. If the water remains clear the other bottles may be treated in succession, the occurrence of turbidity in each corresponding to this scale: 200 c.c. = 12, 250 c.c. = 10, 300 c.c. = 8, 350 c.c. = 7, 450 c.c. = less than 6 per ten thousand. Turbidity is recognized when a pencilled cross on a piece of paper gummed with the face against the lower part of the bottle becomes invisible through the water.

Odor test

Lime-water test for CO_2

XXIII

BARRACKS AND QUARTERS: VENTILATION AND CARE

Air of squad-rooms

It is the special object of sanitary effort inside the dormitory to keep the carbon dioxide within the recognized allowable limit of impurity. The dormitory air is the men's sole dependence for breathing during much of the time, while they themselves are the chief and constant causes of its contamination. The problem is to give them a full supply of sufficiently pure air, notwithstanding their very presence progressively increases the difficulty. Every man actually breathes out from his lungs about three hundred and thirty cubic feet of air during the twenty-four hours. This is equal to twenty-seven and a half cubic feet, of which six-tenths of a foot is carbon dioxide, per hour. Out of doors the contamination would be dissipated spontaneously. Or if the man breathed from and into separate reservoirs, there would be no problem. But in fact every man in an apartment is using air which, if not constantly renewed, may already have been used by some other man, in an extreme case by every other man, and simultaneously he is corrupting the air-supply of his companions. If the expired air acquired a hue, as blue or red, its distribution would need no explanation. But the contaminated air is imperceptible to any sense, excepting that of smell after it has been charged with organic waste. Consequently company officers frequently fail to recognize the evil, as distinguished from the merely unpleasant, effects of overcrowding, for they appear slowly. Nevertheless these evils not only exist but numbers seem to intensify them, so "that the more men are placed together the greater should be the air-supply per head." After the available air has been consumed in respiration, it is immaterial whether the original supply was 600 or 6000 feet. Hence every sleeping-room should have not only adequate floor area and sufficient cubic space, but also means to dispose of the vitiated air and to introduce a sufficient quantity of fresh air. This change of air is ventilation, and the more complete it is with the least discomfort to the occupants the better. "Perfect ventilation can be said to have been secured in an inhabited room only when any and every person in the room takes into his lungs at each respiration air of the same composition as that surrounding the building, and no part of which has recently been in his own lungs or those of his neighbors, or which consists of products of combustion generated in the building, while at the same time he feels no currents or draughts of air and is perfectly comfortable as regards temperature, being neither too hot nor too cold." (Billings.) To obtain perfect ventilation requires a room of special construction and thirty times as much fuel as would heat a room of the same size in the ordinary way; therefore this may be disregarded, as being an impossible ideal for military buildings. But good ventilation, which is attainable, means keeping the vitiated air diluted to the standard of allowable carbonic impurity (6–7 in 10,000).

Ventilation

In brief, the problem of securing health and comfort in inhabited rooms involves an adequate supply of fresh air, the dilution and removal of those consequences of occupation which may be called the vital products, the prevention of the admission of deleterious gases from the operations of lighting and heating and from waste-pipes, the regulation of temperature, and the limitation and disposition of dust possibly burdened with contagion. A man living by himself out of doors would have an indefinite amount of fresh air and, sufficient warmth being assumed, should meet with none of the conditions just noted; and it is an object of military sanitation to reduce to their minima these conditions within doors as they affect troops.

Requirements of air for health and comfort

The size and shape of squad-rooms bear distinctly upon health as well as upon administration. Excepting for temporary pavilions, they should be in the second story, when not in the tropics, to avoid dampness, dust, noise, and in a degree flying insects, and to economize space under the same roof for mess-rooms, amusement-rooms, and offices. The two long sides, and in hot climates one end, should be exposed to the air. Except in the extreme north, every squad-room should have a balcony or veranda, from eight to twelve feet wide according to the latitude, on all the free sides. The verandas protect against excessive glare; if the roof is not too steep they do not intercept necessary sunlight; and they afford convenient places where men may lounge and amuse themselves in pleasant weather and may attend to such minor cares as their arms and clothing, relieving the squad-room proper of unnecessary confusion. A barrack without a veranda as such an adjunct is incomplete. In the tropics broad verandas are secondary living-rooms, as well as shields against the sun that otherwise would beat upon the walls. No squad-room should exceed 24 feet in width (perhaps 23 feet 6 inches in the clear), nor be less than 12 nor more than 14 feet high. As a rule the height above 12 feet may be disregarded in estimating cubic air-space. In the tropics, with punkas or other mechanical contrivances for displacing the air, they may be 18 or 20 feet between floor and ceiling. Excessive width makes ventilation, the complete dissemination of sunlight, and ordinary cleanliness more difficult to obtain. It also creates a fictitious sense of capacity, for the nominal floor-space is not really available and beds along the walls must be unduly approximated at the same time the central space is wasted. To economize material is a constant temptation to build square squad-rooms. With the width and height fixed, the length is regulated by the proposed number of tenants or by the requirements of administration. Undue length interferes with the administration of a squad-room, but not with its sanitation if the proper relation toward winter

Plan of squad-rooms

Veranda

Dimensions

sunlight and the prevailing summer winds is maintained. So its size is hygienically important only as conditioning the freedom and frequency with which the vitiated air can be removed and fresh air be introduced, and in temperate climates this is chiefly limited by the discomfort produced. It must be conceded that a working standard at all approaching an ideal for the competent air-supply of all barracks has never been formulated, beyond the general agreement that each man should have at his disposal 3000 cubic feet hourly. Necessarily the operation of any standard must be according to a sliding scale which would depend upon the apartment and the locality. This not because more air or less is consumed at one place than at another, but because the frequency of renewal is modified by the available cubic space per man, by the temperature, and again by the cost. The colder the outer atmosphere the more uncomfortable will be rapid renewal of unwarmed air, the more expensive will be the heating, and the greater the temptation to use again air already expired. Air that is changed more rapidly than five times an hour (as when the conventional required 3000 feet per man is supplied more frequently than 600 feet every twelve minutes, or fifty cubic feet per man per minute) produces objectionable draughts.

Size in relation to air-supply

It is self-evident that there must be a limit of cubical space below which an adequate air-supply cannot be furnished. For a room permanently occupied with ordinary ventilation, that is for civilian workshops or dwellings, a capacity of 1000 cubic feet per head is the lowest limit. For many years the army theoretical standard for healthy soldiers in ordinary squad-rooms in temperate climates has been 600 cubic feet air-space, based upon 60 square feet floor-space per man, with the expectation that the air would be renewed five times an hour and thus furnish the required 3000 feet, although frequently the actual allowance has fallen short. During the same period the space in barracks south of 36° N., that is practically at the stations in the

Area and cubic space

United States south of Virginia, was estimated in theory at 800 and 70 feet respectively. Later the desire for the tropics was to secure from 1500 to 3000 cubic feet and from 75 to 150 square feet according to locality. The latest decision of the constructing officers is reported to allow 720 cubic and 60 square feet in all dormitories, while the hope of the medical department is to secure 1020 cubic and 85 square feet in the temperate zone, and 2000 cubic and 100 square feet within the tropics. In the writer's judgment 840 cubic and 70 square feet may be accepted as desirable and sufficient outside the tropics. (It is of interest to remember that in the plains of India the British allowance is 1800 feet air-space and 90 feet floor-space, with the number of men never to exceed 24. In the United Kingdom the allowance ranges from 500 to 600 cubic feet over 50 to 60 square feet.) In apportioning the occupants to a squad-room, the maximum number of beds is to be determined strictly according to the floor-space, regardless of average occupation; but in allowing for air-space it will be legitimate to take account of the percentage that will be constantly absent, as on guard, detached, sick, on furlough, or otherwise accounted for. Remembering that, it will always be safe to arrange for a theoretical air-space slightly below that which the number of beds would require, for all of these can never be expected to be filled at once except on the most special and temporary occasions. On the other hand, it will be expedient to calculate for the renewal of air according to the number of beds, partly because a constant absentee rate cannot be accurately fixed, partly because thus a formal standard for daily use and for general comparison may be more certainly set up, but chiefly because it is better for the fresh air to be somewhat in excess than to fall short of actual need. It is always easier to diminish than to increase the supply.

Present standards

As a practical illustration of the arangement of area, or floor space, the following example may be considered. The superficies of a room 24 × 70 feet would be 1680 square feet.

Parallelogram and square

If 28 men were assigned to it, each would have 60 square feet. This would represent a strip two and one-half feet wide across the room; or, the bedsteads being in two rows, the space for each individual would be five feet by twelve. That is, every three-foot bed has one foot of space on each side, so that if placed uniformly they would be two feet apart. But grouping them in pairs and drawing the members of each pair within a foot of each other, the pairs themselves would be three feet apart, the corresponding five feet in the centre aisle representing common ground. Now suppose the 1680 square feet of floor space to be a square instead of a parallelogram; then each side of the square would be 41 feet, or 164 linear feet in all. Arranged on two sides of the room, disregarding door-ways, there would not be quite room for all the beds even if they touched one another. To place the beds around the four sides, two of the sides would lose at least eight feet at each angle or 32 feet in all, and at the very least 9 feet (more probably 15 feet) must be subtracted for three doors, leaving 123 or 117 feet available, as the case might be. By the closest calculation each bed might have a trifle over four feet laterally, or placing members of pairs six inches apart there would be but two feet between the independent pairs. With these thus crowded, the centre of the square (27 × 27 = 729 square feet) would be unavailable for true dormitory uses, while the space under the beds could be policed only with difficulty. That this is not a mere theoretical difficulty, the case of Fort Larned, Kansas, (now discontinued) shows. In 1867 three out of four squadrooms built that year were 40 feet square and 10 feet high, with no direct communication with the open air exclusive of doors and windows. In 1869 two of these rooms were occupied by 35 and 42 infantry respectively, and the third had recently been filled with a cavalry troop. These men occupied two-tiered double bunks, four men in each bunk; the cavalry had used three-tiered double bunks. Some device of this kind was necessary to enable the men to be housed, although by it they received only 381 and 457 cubic feet air-space respectively, with small chance of renewal, especially in the winter. Reflection on such incidents is sometimes desirable to enable progress to be appreciated.

Length of squad-room

Dwellings as quarters

Renewal of air

For convenience of discipline multiples of eight, a corporal's squad, would be quartered together and two or three extra beds for sergeants added. Both the Quartermaster's and the Medical departments' relations of floor-space and air-space assume a ceiling 12 feet high. With a floor area of 60 square feet per man (the Quartermaster's standard) and a width of 23.5 feet, 26 men would require a room 66.5 feet long, or with a width of 24 feet it should be 65 feet in length. Thirty-four men would need nearly 87 or 85 feet, as the case might be. With a floor area of 85 square feet (the official medical estimate) 26 men would require a length of 94 or 92 feet, according to the width. Should 70 square feet and 840 cubic feet be adopted, then 26 men would require a room 77.5 or 76 feet long and 34 men one 101 or 99 feet in length. When, as is sometimes the case, it is necessary to quarter troops for a short time in ordinary dwellings and without cots, a somewhat smaller allowance of air may be accepted in the emergency, and the conventional rule is: For rooms 15 feet wide, one man to every yard in length; for those between 15 and 25 feet wide, two men to the yard; for rooms wider than 25 feet, three men to the yard. It is better that the men should be required to lie in two rows, heads to the wall. Assuming that the ceilings are 10 feet high and there is no furniture, each man of the first class will have 450 and of the second and third classes 300 feet air-space. If the ceiling is 12 feet high, add 90 and 50 feet per man respectively. But this allowance is too small for permanent occupation, unless there are exceptional facilities for the exchange of the air. It is generally conceded that in living apartments, whether by day or by night and regardless of their size within common limits, 3000 feet of air should be supplied each man every hour. If 600 cubic feet be the air-space per man, then it should be replenished five times an hour, or once in twelve minutes; if 720 feet, then about four times, or once in fifteen minutes; 840 feet would require change about three and a half times an hour; and 1020 feet rather less than three times, or once in a little more than twenty minutes. Clearly the more slowly the air moves, provided it moves at all, the better; but at the same time the larger must be the apartment, with a corresponding increase in its first cost and general maintenance. These figures are introduced for convenience of reference, the particular point to remember being that an adequate air-space constantly refilled is essential.

Ventilation

All ventilation depends upon two conditions. The first is the diffusion of gases, which is the property by which every gas will freely and rapidly expand into the space occupied by another gas, practically as though this space were a vacuum, and the mixture will not redistribute itself. This takes place inversely as the square root of their densities. Thus from equal volumes of oxygen and hydrogen one part of the oxygen will pass into the hydrogen to four parts of the hydrogen into the oxygen. The second is the entrance and exit of the air from and into the outer atmosphere. Now, time being given, the diffusion of gases establishes a uniform quality throughout the apartment, a uniformity of foulness as well as of freshness, which is the essential reason why copious dilution with pure air should be constant. Floating organic matters, however, are not affected by the lawof diffusion as much as by the air-currents within the apartment. Although diffusion is a constant and a reasonably rapid process, the contaminations in the expired air do not immediately fly off uniformly into space, and the process of diffusion does not directly overcome the effects of currents induced by differences in temperature or otherwise. In an undisturbed atmosphere it is probable that the organic matters given off into it gravitate to

Floating organic matters

the bottom of the room or settle upon its stationary contents. But that is not the case with carbon dioxide, which, although heavier than an equal volume of air, does not obey the law of gravitation in preference to that of diffusion; and when there is much difference in composition between the upper and lower strata of contained air the upper is usually the more impure as well as the warmer, because as a whole the air heated in the lungs or by combustion rises and carries with it its varied contaminations. Whatever volume of air may be allotted to any particular barrack, the proportion per man should be somewhat greater for the cavalry so as to dissipate the unavoidable stable odors. And hospitals, whose sick give off emanations charged with specific poisons of their own, require their extreme dilution. In fact the more nearly a military hospital ward can be thrown open to the outer air, the better adapted, other conditions being equal, will it be as a place of care for the sick.

Cavalry

Hospitals

Ozone, which is an allotropic and denser condition of oxygen, probably arranged as O_2O, possesses a very much higher oxidizing power than oxygen; so it is probable that if the fresh air contains ozone, the more of such fresh air there is the more rapid is the oxidation and simultaneous destruction of at least some of the disease causes. Certainly when free ozone is to be found it may be inferred that there is very little or no organic oxidizable matter present.

Ozone

All natural ventilation, independently of that associated with the diffusion of gases, depends upon differences of temperature whereby the relative positions of parts of the atmosphere are altered. The most conspicuous and constant illustration of atmospheric ventilation due to heat is that of the trade winds, and of course storms, which violently move great masses of air, and the gentler breezes that refresh without being destructive, depend in the end upon the same agency. On the other hand where the

Exterior ventilation

temperature is nearly uniform over large regions, especially in great forests or valleys when it is very hot, occasionally the air may not move much and the oppressive feeling of stagnation is not imaginary.

Interior ventilation

But in connection with residences, large or small, provision must be made not merely for the movement of air within the building but also for the entrance of fresh air and its escape after use. The introduction and extraction of air by machinery is necessary in large and complex buildings and, as artificial ventilation, is the province of the civil engineer and the architect. That is entirely beyond the scope of this work, which concerns itself only with simple and ordinary barracks where the change of air follows the movement of the external atmosphere, sometimes supplemented by the influence of combustion, and this is natural ventilation.

Natural ventilation

In common with artificial ventilation this requires provision for the escape as well as the entrance of air, and in its simplest form is by means of open doors and windows on opposite sides of a room, so that the wind may blow directly through it.

Perflation

This is known as perflation. Perflation should be practised daily and systematically in every barrack, regardless of the external temperature, so as to sweep out all the air previously present. The exception is when rain or snow would drive in on the windward side, but even then the opposite side should be open for part of the day. This cannot be kept up in severe weather while the room is occupied; and whenever the external temperature is much lower than that within, the discomfort of cold draughts forbids the partial opening of windows for any considerable time. But every room in barracks, squad-room or other, should be thoroughly flushed in this way daily, driving storm alone preventing. Natural ventilation, apart from perflation, depends upon aspiration.

Aspiration

The atmosphere moves across chimneys, or other openings especially arranged for communication with the interior, and thus creates theoretical vacuums at the outlets into and through which the interior air escapes, or, as popularly expressed, is drawn out. The upward movement will be proportionate to the lateral movement of the outer air diminished by the friction of the channels. The condition for an outward movement is the opportunity for air to enter the apartment as well as to escape, nor can air enter unless there is also opportunity for the enclosed air to be released. The two conditions are complementary, as illustrated in the operation of a common stove, which cannot "draw" if the pipe is closed or the draught hermetically sealed. Hence also in warming a well-built house by a hot-air furnace the effort "to keep the heat in" by closing openings into the outer air fails. The hot air cannot enter the plenum thus constructed. But when a window is raised for the escape of contained cold or contaminated air, warm fresh air at once flows through the registers to replace it. It should always be remembered that fresh air is not necessarily cold air. Air may very properly be warmed before it is breathed without inducing any other change in its character, but no system of natural ventilation will make the air in the house cooler than that outside. It is not hygienic ventilation when the incoming air is not fresh, or the outgoing air does not pass directly into the outer atmosphere. To connect the air of a sleeping-room with that of an attic, whether the latter has windows or not, does not necessarily ventilate either.

Air must escape as well as enter

Fresh air

For comparatively small and not overcrowded apartments these simple methods for the admission of air to replace that escaping through a chimney or other flue, or sometimes by reverse action through a part of these very openings, are: (1) Where the sashes do not come together accurately, wedges in the line of junction will allow a considerable volume of air to enter along the crack and escape by the chimney or other flue; (2) Transpose the sashes, and air will enter where the displaced borders do not fit closely; (3) Raise the lower sash a few inches and fill the space beneath with a light board, when air will flow in where the sashes no

Simple ventilation

longer touch; (4) Where the sashes are double, as with storm windows, at least one outer pane in each should be movable and the inner sashes be raised or lowered as required; for a somewhat larger apartment in a moderate climate fair ventilation may be established by one or more boxes or tubes crossing the room just under the ceiling, each with a perpendicular diaphragm midway and freely open at both ends. When these conduits have numerous good-sized perforations the air will enter the apartment from the half toward which the wind blows and it should escape through the other half. The volume of air that enters may be regulated by valves at the extremities, and one side of the box, or the lower half of the tube, should be hinged for the stated removal of dust.

Inlets

It is easier to introduce enough fresh air than to regulate it so as to avoid unpleasant draughts. Where such draughts do occur, sooner or later the occupants will block the inlets, preferring the insensible evils of insufficient renewal to the direct annoyance of cold currents. Hence the size and location of the inlets must always be important. The currents of air are liable to be disagreeable in proportion as the space through which they may be broken and deviated decreases. Thus, to supply 3000 cubic feet of air per hour would require the presumed 600 cubic feet of air-space to be renewed five times within that period. Or should, as sometimes happens, there be only 500 feet air-space per man, then that amount must be introduced six times an hour. It is repeated that the more crowded the squad-room the greater necessity for freely and frequently diluting the inevitable contamination. Now, if the apartment is small, these currents may be difficult to manage and at ordinary winter temperature they would be uncomfortable to encounter. Thus, if a space of 500 cubic feet is to be supplied six times an hour, or once in ten minutes, through an inlet of 24 square inches (the English standard per head), the rate would be 3.4 miles per hour; if the inlet were 12 square inches (a slit one inch by

Rate of supply

Air currents

twelve, two inches by six, or an opening three inches by four), then the rate would be nearly seven miles an hour, a brisk sailing breeze, and in contact with the person would usually be insupportable. Where the air-space is 720 feet, the air must be renewed a little more than four times, for 820 feet three times and a half, for 1020 feet a trifle under three times an hour. In all these cases the cooler the air the more disagreeable will be its contact, and the warmer up to about 100° F. the less it is perceived. As the air must be introduced in the same ratio, whatever that may be, for every individual, it is evident that the position of the inlets must be established with care, and with our greater range of temperature the 24 square inches of the English allowance may be reduced to 12 inches per head, always provided that the smaller and swifter current does not fall directly upon an occupant. After all, it is principally when artificial heat is required that special concern may be taken about inlets, unless unreasoning dread of night-air leads to closing doors and windows then. In the tropics the perflation that may always be depended upon obviates the necessity for special inlets. On the other hand in northern latitudes, especially in winter, the difference in temperature is a chief factor, and ventilating openings are smaller or fewer as this difference increases.

Outlets

Outlets are equally important as inlets and generally the section-area of the two sets of openings should be equal. The exception is that a strong outgoing current over a large area, as a chimney, makes the indraughts through small sections more rapid, so that not so large a superficies is required. In fact small rooms where doors are frequently opened, as in officers' quarters, usually require only places of exit; and most walls of dwellings, unless especially massive and well built, are permeable to air. This is particularly true in wooden houses and where the plastering is laid directly upon the brick. This mural permeability is one reason why the appar-

Officers' quarters

ent want of ventilation is not more serious in its results, but it should not be depended upon to replace a careful system of window- or transom-ventilation. Painted or papered walls are more nearly air-tight. But however air may be supposed to enter, chimneys should not be closed, as a false sense of economy or of appearance sometimes directs. A chimney is an excellent ventilating shaft for an entire house, and although a fire may not be required the chimney itself should always be freely open. Occasionally a disagreeable flow of cold air in the season where fires are not required may pour down the chimney. This current may easily be reversed by placing a lighted lamp in the fireplace or just below the opening of a flue. A chimney sometimes smokes because there is insufficient fresh air to maintain a competent draught. In that case opening a window relieves the difficulty.

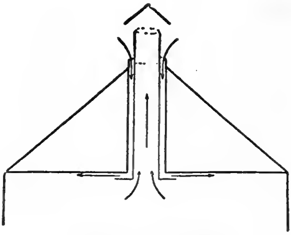
Smoky chimney

When ventilating shafts as such are required, they should be small and numerous rather than large and few. A mere channel between the inner and the outer air, if it is tortuous or if the interior is rough, is not necessarily sufficient. Friction greatly retards air in motion, so that the smoother the surface the more readily the air flows. If a change of direction is required, the passage should be curved rather than crooked. Every right angle materially diminishes the progress of the air. The air-shafts should be placed to avoid direct currents between entrances and exits, for it is quite possible for the stream of air to pass directly through a room without materially disarranging the contained volume. The inlets should be arranged also to divert the air from plane surfaces along which when not disturbed it has a marked tendency to adhere and roll, instead of immediately diffusing itself throughout the enclosed space.

Character of air-shafts

Air-shafts

The method most generally convenient for the admission of air to ordinary barracks is by shafts, whose outer ends curve down, which open directly under the heating apparatus. The exterior curve is to prevent the wind blowing with violence directly through. When the stove or the steam coils are jacketed, the air is warmed before it circulates through the room and does not flow over the floor while yet cool. Exit shafts are to be placed in the ceiling near the eaves on both sides of the room. These should be tall enough to use the aspirating force of the wind from either direction. In very cold weather, or when there is danger that cold air may enter these channels on one side of the building as well as escape on the other, valves may be introduced to prevent or regulate it. Where the inlet and outlet tubes are distinct and no aspirating or expulsive apparatus is used, if the air is warmed before it is distributed it should be admitted near the floor; if it is cold, then near the ceiling and the exits be reversed in position. A very simple and sometimes an effectual plan of ventilation is a series of tubes through the ceiling on both sides of the room extending higher than the ridge and divided longitudinally into two or four of smaller calibre. The air enters through one channel and escapes through another. This does not directly provide for its distribution within the room, so that the air which enters may escape immediately. A better method is by the M'Kinnell tube. Here one shaft is enclosed within another of larger area, both of which pass from the ceiling through the ridge, the inner tube being the longer in each direction and having a wide flange at the lower end. The heated air will escape by the inner tube, and fresh air should



M'Kinnell's Tube.

M'Kinnell's tube

enter by the outer channel and be diverted throughout the room by the lateral projection. The flange or shelf should be carefully wiped daily and be inspected for dust at least weekly. Ridge ventilation, peculiarly adapted for temporary hospitals, is also perfectly applicable to the simpler barracks, particularly those of the pavilion type, in warm or moderate weather. It is in substance an opening twelve to eighteen inches wide, taking off the crest of the ridge for a part or the whole of its length, and covered by an independent roof eighteen to twenty-four inches higher. This secondary roof has hinged sides, which may be lowered as required to close it in. If the barrack is ceiled, a boxed opening connects the squad-room with the opening in the ridge, and the passage of air through it may be regulated by hinged flaps controlled by ropes over pulleys. If there is no ceiling, then there is no construction below the ridge. In the cold season a modification of ridge ventilation is found in boxed shafts, eighteen to twenty-four inches square, running from the tie-beams to beyond the ridge and utilizing the stove-pipe to aid the outward current. In hot climates where natural ventilation is sluggish and electrical power is available, electric fans placed so as to drive air into the apartment and also to expel it are particularly serviceable. In order to guard against unnecessary discomfort from reduced temperature or high winds, it should be possible on occasion to diminish the calibre of the inlets to correspond with the rapidity of the flow; but that the valves may not be tampered with, they should be set by a non-commissioned officer and the sergeant in charge of quarters be made responsible that the system is not molested by day or by night. This is true as well for the electric fans. Otherwise some ignorant soldier will seek warmth at the expense of fresh air. The state of the ventilation should be a constant subject of intelligent solicitude by the company commander.

Ridge ventilation

Electric fans

A company officer should not be entirely satisfied that his men are properly quartered when they are protected from the weather, have the standard air-space, and an adequate renewal of fresh air in proportion to their number. His inspection of barracks should include possible leaks from gas-fixtures, waste-pipe traps, soil-pipes, the products of combustion in stove, furnace, or through illumination, and organic decomposition in closets and cellars. Every odor should be traced to its source. The decay of any form of organic matter within a barrack is simply inexcusable and is *prima facie* evidence of negligent policing; but because it is possible, the integrity of the food supplies must always be assured. The fresh-air supply of heating furnaces or of cold fresh-air shafts should be carefully guarded against contaminations from drains and slop deposits, and the furnace proper or the iron stove from cracks or imperfect joints through which the gases of combustion may escape, or red-hot cast iron which may allow carbon monoxide in particular to pass through it, into the hot-air chamber or directly into the apartment. Steam and hot-water coils do not pollute the air. Plaster, brick, and porous stone ultimately absorb organic poisons, which is a special liability of hospitals and guard-houses, and may easily follow over-population of a dormitory. Such walls and ceilings should be scraped at least once a year and be lime-washed twice a year with fresh lime. The plaster should be renewed at least once in ten years and after any epidemic. A hard-finished wall may be washed down with a disinfectant or otherwise when required. As a matter of routine this should be done every six months and paint be applied every two years. On account of the relative impermeability of such a wall, the inlets for air must be numerous and abundantly sufficient for the number of occupants.

Barrack inspections

Purity of air-supply

Treatment of walls

The use of protective netting is a required sanitary precaution wherever the so-called "malarial" and the yellow fevers may occur, on account of the well-established agency of the mosquito in propagating those diseases. It is impracticable to keep a whole barrack

Mosquito netting

free from all flying insects by exclusive netting, but every bed should be efficiently enclosed and the careful use of individual netting be enforced as a part of routine discipline. Outer doors may well be screened, and notwithstanding its obvious interference with the pleasanter breezes the verandas themselves in the more unwholesome localities should be covered in with competent meshing. It is an error to make barracks unduly large, either in the width and length of individual squad-rooms or by the addition of unnecessary rooms, for the possible convenience of the extra space does not repay their care. Certainly they should not exceed twenty-four feet in width, for reasons already assigned. Wainscoted walls become frequent harbors of vermin. Receptacles of all kinds should be reduced to the minimum, and in permanent barracks wall lockers are better arranged with glazed doors for ease of inspection and as a constant incentive to orderliness. Independently of discipline, the squad-room should contain no personal property not required on duty. Everything else, and especially civilian clothing if such is permitted, should be in another room in a non-commissioned officer's charge. Every object diminishes the air-space by the measure of its own bulk, facilitates the collection of dust about it, and interferes with sweeping and general cleaning. Bedsteads should not be placed directly against the wall. Neither should steam-coils in dormitories be placed near the walls, which means near the sleepers' heads, as is a temptation for economy of space and sometimes for the easier access of the supply pipes; but their proper position for uniform and harmless heating is along the central line. All bedding should be opened up daily, and be sunned half a day at least once a week; and it should be inspected irregularly for soiled clothing and contraband stowed below the mattress or under the pillow. Blankets should be aired every fine day and occasionally be beaten. Points like these, minor and commonplace as they are, are important in the aggregate;

Superfluous space

Contents of squad-rooms

Beds and steam-coils

sage, 1000 cubic feet as a minimum, and this to be changed at least six times an hour. It is an error to suppose that the reduction of temperature which a reasonably frequent change of air may involve may be carried too far in a temperate climate. A British veterinary authority, F. Smith, quoted by Notter and Firth (*Hygiene*, 3d ed., p. 182), from whom also the foregoing data are derived, "considers that with proper feeding and attention the air about a horse may be changed every three minutes, or twenty times an hour, although the coat may not turn out as glossy as in a warmer stable." Of course this depends somewhat upon the external temperature, but in fairly moderate climates a horse will do perfectly well out of doors with some protection from storms. Horses like men formerly were badly crowded and they suffered the necessary consequences. In the French cavalry stables prior to 1836 the mortality ranged from 180 to 197 per 1000 per annum. In 1862–66 it was 27.5 per 1000. In the war of 1859 10,000 horses were kept in open barracks, with scarcely any sick and but one case of glanders. During the Civil War horses were kept in perfectly good condition in Virginia under a simple roof of boughs, which broke the force of the summer sun and intercepted the winter snows. Doubtless this is not unique.

XXIV

CAMPS

A bivouac implies that the troops are resting for the night in the field, with no other shelter than they carry upon the person or which may be extemporized, or with none at all. A camp implies that the troops are sheltered by tents or temporary structures. Where shelter-tents are carried, bivouacs and camps shade into each other and for our purposes may be treated as identical, notwithstanding the life of what was originally a bivouac or a provisional camp may be indefinitely prolonged. As distinguished from bivouacs, camps are temporary or are those of position. The former are usually determined by conditions which are insistent but transient. These would be the position of the enemy, the necessity for concentration, or contingencies which, however imperative originally, may pass away at any time. An example is the halt of the Army of the Potomac before Yorktown in 1862 (Camp Winfield Scott), or the collective camps at Tampa and in Chickamauga Park in 1898. As it is impossible to foretell its duration, whatever may have been the primary intention, every temporary camp should be managed from the beginning with the same care that would be required if its permanence were then assured. Camps designed to be permanent are deliberately established for some ulterior purpose and, when possible, only after the site has been carefully chosen. But in war the necessities of the campaign usually control the situation. Permanent camps are divided into those of instruction and those of war. Camps of instruction should have sites well prepared by clearing, grading, and underdraining; they require abundant pure water for drinking, cooking, and

Bivouacs and camps

Permanent camps

Camps of instruction

individual bathing made accessible artificially; facilities for the prompt and complete removal or destruction of all kinds of refuse; adequate field kitchens; sufficient tentage; artificial illumination; and protection when required against flies and mosquitoes. The experience of the large encampments at Pine Camp, N. Y., and Atascadero, Cal., demonstrate that thousands of troops, the majority inexperienced, may be kept in camp entirely free from disease arising there or spreading from an imported case. These remarkable achievements should not condemn war camps which fail to give equal results under harmful conditions; but they place upon commanding officers the burden of proof in determining how far such conditions are without remedy. Camps such as cited establish a standard to be emulated if not equalled, and their appliances and administration become models for study.

Bivouac

The essentials of even the most transitory over-night resting-place are water, wood, grass or, alternatively, accessible grain or fodder, and the avoidance of marshy ground. Wolseley's advice, to interpose when possible a screen of woods between an infantry camp and the enemy as a military precaution, applies equally to such a barrier before the breeding-places of mosquitoes. However, it is hopeless in active campaign, particularly during operations not of our own choosing, to anticipate always finding situations that are favorable in their natural state; but responsibility is not removed because of difficulties to be overcome. The competent commander studies the general character of the available ground in its sanitary as well as in its aggressive or defensive facilities. To that end a medical inspector should accompany the reconnoitring engineer, for notwithstanding sanitary advantages frequently must give way before military considerations, they should not be causelessly abandoned or ignorantly disregarded. The difficulty in selecting resting-places increases directly with the size of the command, until finally little remains but to make the best of assigned situations. Here the primary responsibility rests with the corps or division commander, through his staff. In an independent march the halt for the day should by preference be determined according to the sanitary conditions. It is better to march even fatigued men two extra miles to dry ground with accessible water, than to risk health by bivouacking on marshy soil or among the remains of an abandoned camp. Possible detention must be ever in mind, for in war to-day's resting-place may be occupied for weeks.

Hills and streams

The deliberate selection of ground for the protracted camp of a large command involves the same principles that apply to sites for permanent posts, and even small commands or mobile columns should disregard those rules only through necessity; for while circumstances may modify their administration, the laws of health do not change. During the commoner season of military activity, a position on a hillside is more desirable than one on its summit or in the valley, potable water always being accessible. In cold weather the brush of the valley is more acceptable, no military reason contravening. Convenient proximity to water is the first sanitary consideration, malaria-bearing mosquitoes being absent and the soil not wet. Bivouac should not be made in the dry bed of a torrent nor below the first bench of a shallow river, for in each case cloud-bursts or distant storms may fill the channel without warning and with disastrous results. If time is important, camp should be made on the further side of unbridged streams, lest they rise in the night and prevent crossing. Should time not be important, in the mosquito season it is better to encamp on the windward side to avoid those insects. In the field a small fire is best for personal warmth and is more easily managed for individual cooking. An Indian will squat over such a fire or lie down beside it and be comfortable, while an uninstructed white man builds one so large that he cannot approach it and is cold. Men should not be allowed to sleep directly upon the ground, except in the rainless regions of

Personal fires

the interior and there only when the ground-water is low. This is particularly true for raw troops or for those long in garrison, for it seems that men seasoned by prolonged and active life in the open air acquire a moderate immunity against conditions ordinarily harmful. The rule is to protect the body when in repose from becoming wet, because that condition reduces the temperature, not only directly by the difference between that of the water and that of the body itself, but indirectly by the evaporation of the moisture upon the skin. Besides, although the ground may not be perceptibly wet or even damp, the coolness of so great a mass rapidly conducts physical heat away from the body. In sleep there is always some reduction of vital resistance, which opens the way to depression when the ever-present soil-dampness has direct access to the person. Hence a waterproof sheet should be interposed between the sleeper and the soil. Even sand that may be torrid in the sun radiates heat so rapidly as to become cold in the night, and other soils fluctuate in temperature and in humidity according to their composition and the season. Consequently straw, hay, boards, rails, even fresh boughs (although green foliage is generally objectionable), should be insisted upon for a resting-place. It is better to lie even on dry stones, guarded if possible by straw or a blanket, than upon the ground itself. New troops must be taught that a blanket or similar protection is as necessary under the body as over it, whether on a cot or lying out, for much discomfort arises from becoming chilled from beneath. It is more important to avoid wet soil when at rest than to keep out of the rain when in motion, for it is a common experience that, except in abnormally severe weather, active exercise generates sufficient animal heat to preserve an equilibrium in temperature. Generally speaking, while snow is falling the atmosphere is exhilarating and physical spirits are high. It is when snow evaporates in an otherwise humid climate and the air becomes raw from an excess of unprecipitated moisture, that suscepti-

Sleeping on the ground

Rain and snow

bility to colds and general depression increase. But on the trans-Mississippi plains fairly deep snows will disappear leaving no appreciable dampness. To sleep under deep dry snow is no particular hardship when one is reasonably well clothed, because snow acts as a non-conductor and does not dissipate the heat of the body, while it is sufficiently porous for respiration to continue notwithstanding it may cover the head.

Wind-break

In the absence of tents protection from the wind may be had within a circle of earth 18 feet in diameter with walls 3 feet high. The earth should be thrown up from the outside, not from within, which secures exterior drainage and an undisturbed surface to rest upon. The single entrance should be to leeward; and there may be a small fire in the centre, toward which the men's feet should point. When a camp outlasts a day, whether tents are used or not the sleeping-places should be at least a few inches above the ground, and men accustomed to wood-craft will prepare them spontaneously. As already noted, the objection to encamping in the woods is pure prejudice, and a fairly open wood is more acceptable than a bare field, other things being equal. Even a dense wood, if the camp is to endure, may be thinned out to be both habitable and pleasant. In 1898 certain volunteers permitted through a superficial looseness in discipline to sleep on platforms in trees 10 or 15 feet in the air retained their health, possibly on that account, when their comrades sleeping near the ground were sick. This may have been because they escaped all terrestrial dampness, or because they were a little above the common range of the malarial mosquitoes. Irregular formations are not always unwise. In the absence of tents, where small trees are available convenient temporary shelter may be made by resting a pole on two or more forks, or lashing it four or six feet above the ground to saplings, and piling against it at an angle of forty-five degrees branches with the thick ends up. A modification of this would be shelter-tent canvas pegged to the ground and tied to a fence-rail or other

Camping in woods

Temporary shelter

pole, either perpendicularly as a wind-break or at an angle to shed rain or intercept dew, with straw or hay to lie upon. These are expedients for the night. But when it is not raining, although it may be convenient to be under cover it is of comparatively little importance, whether by day or by night.

Wall tent

Four styles of tents are issued. These are: (1) For officers' use, the wall tent. This is 9 feet square at the base, with a wall 3 feet 9 inches high at the sides and rising to the ridge 8 feet 6 inches from the ground. Its floor area is 81 square feet and its air-space 500 cubic feet. It is covered by a fly or false roof, which extends about a foot beyond the wall and, when properly pitched, leaves a non-conducting air-space above the roof proper. The wall tent is designed for one or two officers, according to rank, in camps of some permanence. During active operations company officers may use tents like their men's or none at all, and those of higher rank are more and more crowded together.

Common tent

(2) The common tent, also known as the "I," or the modified "A," tent. Its wall is 2 feet; the base 8 feet 4 inches by 6 feet 10 inches; the ridge is 6 feet 10 inches from the ground. It has no fly. This tent has an opening for ventilation, 3 by 6 inches, front and rear, each opening covered by a movable flap. Ordinarily, when such ventilation is required at all, this is insufficient. The floor area is 57 square feet and the air-space 250 cubic feet. Officially one of these tents is allotted to four mounted men or six not mounted. Lying across its width each infantryman would have a trifle less than 17 inches; lying parallel with the length they would have 13 inches; cavalrymen after stowing their saddles would have 25 inches the longer way and not clear the walls — in either case an absurdly impossible space. For the most moderate comfort the occupants should be half the number in each case.

(3) The conical or modified Sibley tent. This has a circular base 16 feet 5 inches in diameter, a wall 3 feet high,

and it converges to a hooded opening, 18 inches in diameter, 10 feet from the ground, and the hood which protects the top may open at one side and at the apex. This tent has a floor-space of 212 square feet and an air-space of 1450 cubic feet. One such tent is allowed 17 cavalry or 20 infantry, the men lying with their feet to the centre. For half that number it is comfortable in a fixed camp or on a slow march. The advantage of the Sibley is that it may have in the centre a stove whose smoke is conducted to the peak where it escapes, and it may always be well ventilated. It is therefore very comfortable when not overcrowded. The introduction of the low wall greatly improved it over the original Indian model. A modification recently proposed but not yet adopted for general issue is to substitute a rectangular for the circular base for greater convenience of occupation.

Conical tent

(4) The shelter tent. No army any longer pretends to carry cumbrous tentage on active campaign, for it invariably outmarches its heavy baggage. The difficulty with which such equipage keeps up with it increases directly with the size of the army and the badness of the roads, so that a few tents for headquarters and for the shelter of the daily sick are all that are carried on wheels. Even these are sometimes left far behind. Consequently where tents for the rank and file are used on campaign at all, they are borne by the men themselves. The *tente d'abri*, or shelter tent, consists of two pieces of canvas each 65 by 61 inches, with a triangular flap 57 by 52 inches, attached to one end. Each piece constitutes a shelter-half, and two pitched together afford shelter for two men. The halves are buttoned together over slender jointed poles, supported by similar poles, also part of the equipment, so that the ridge is nearly 4 feet from the ground and the base of the tent is 5 feet 5 inches in length. One end is closed by the flaps at an outward angle, which increases the length by 12 inches. The other end is open. Four detachable straps and buckles

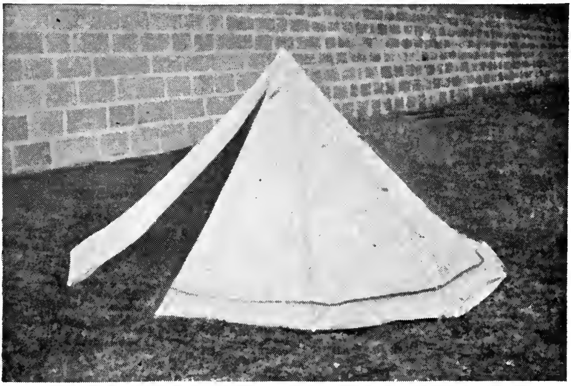
Shelter tent

serve to make the half the cover for a compact clothing roll when desired. When dry each half weighs three pounds and two ounces, but its weight is much increased by rain. As the name implies, this tent furnishes mere shelter against the weather and that is all. In the field every man carries his shelter half, on the top of his pack or behind the saddle; or, when the blanket roll is used, it makes a wrapper for it. The pegs and jointed poles, which are light and fragile, are carried in the half or are extemporized as required. It is possible to unite two of these tents, so that four men, or half a squad, may be sheltered together.

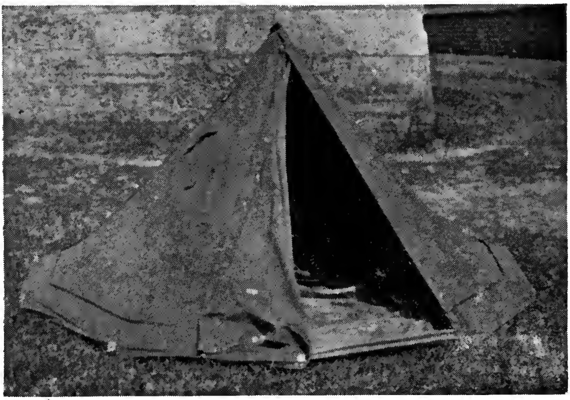
Mason Cape-Tent as a Garment.

Mason cape-tent

There has very recently been devised by Lieutenant Mason, of the army, a combination tent and water-proof cape which, notwithstanding the inherent objection against any article attempting to discharge two diverse functions, is sufficiently plausible to warrant trial on a large scale. Pitched as a tent it is a low cone supported by a central jointed rod (the inventor prefers the rifle) and held to the ground by pegs. The base is about seven feet in diameter and the height sufficient for simple shelter. On a very wet or crowded site two men may coöperate, one supplying a water-proof floor-cover and the other the tent. As a cape it is a complete covering except for the head and fore-arms, and it is large enough to wear over the blanket-roll if



Mason Cape-Tent pitched for One Occupant.



Mason Cape-Tent for Two (Waterproof Floor).

required. Not worn as a cape, it may enclose the blanket-roll or lie folded on the knapsack. The material is strong, light cotton, water-proofed with lanolin, permeable to air and not subject to mildew. It weighs five pounds. As either tent or cape it probably will be efficient. Difficulty will arise when a man on duty in a severe rain must transform his tent into a water-proof cape or cloak. This might be avoided if it could be arranged that two men should always tent together and that both would not require to wear their capes simultaneously.

Hospital tent

Hospital tents are larger wall tents (14 by 15 feet at the base with a 4-foot wall and the ridge 12 feet from the ground) that may be freely opened at each end and thrown together in extension. These always have flies, to protect against heavy rains and lessen the internal heat. Nevertheless in very hot climates the temperature within all tents, due to the thinness of the walls, is much greater than that within ordinary houses. Munson has therefore devised a tropical tent whose fly shall be white to reflect the sun's rays, and the tent itself be drab. The fly, which is 2 feet longer and 4 feet wider than that of the standard tent, rests on a false ridge one foot above the true ridge and 2 feet longer. A section of the tent roof 4 feet wide (2 feet on each side of the ridge) and 12 feet long is replaced by a rope netting. This is to secure ridge ventilation, and the netted opening may be closed in whole or in part in bad weather by a supplementary flap. It has been found that in very hot weather the temperature in such a tent has averaged 7° F. less than in an ordinary hospital tent and it has been as much as 18.5° F. lower than in a conical tent. This principle with a modification of the plan has been adopted in the tropical tents of the wall and hospital patterns now issued for hot climates. In the wall tent, instead of using a false ridge greater stability appears to be secured by sewing a strip of canvas 12 inches wide into each side of the roof 12 inches per-

Munson's tent

Tropical wall tents

pendicularly below the ridge. This makes the floor of a triangular pocket, known as the ventilator, the length of the tent and at its highest part. In this floor are six holes six inches in diameter. Triangular flaps at each extremity of the pocket may be opened or closed at pleasure. When opened, the natural draught carries the warmer air into the ventilator, whence it escapes. In each end of the tent is a canvas door and the whole of either end may be opened and folded back. This tent is almost exactly 9 feet square. It is 7 feet 6 inches from the floor to the ventilator, and the wall is 3 feet 9 inches high. It has the same fly as the ordinary wall tent.

Tropical hospital tent

The tropical hospital tent is 14 by 15 feet at the base, and any required number may be placed in extension. The wall is 4 feet 7 inches high; it is 10 feet 6 inches to the floor of the ventilator; the depth of the ventilating pocket is 18 inches; and the ridge pole is 12 feet from the ground. The base of the ventilator contains four holes each one foot in diameter, and each side of the pocket has four holes each six inches in diameter. A movable flap closes each extremity of the pocket under the ridge, and, when these are open, theoretically there will be a current in one direction or the other, supplied by the air escaping from the body of the tent and assisted by that entering or escaping from the lateral openings. This supplies an excellent type of ridge ventilation. A small fly 6 feet wide (3 feet on each side) is stitched the length of the tent to the top of the pocket, to be extended or brailed up as desired. This guards against reverse currents and against draughts from too rapid change of air. The ordinary fly covers the whole tent. A canvas door is at each end, and the ends themselves may be closed or be folded entirely back.

The best military tents are made of cotton duck, which is permeable to air when dry and whose fibres when wet swell sufficiently to exclude ordinary rain. Tents of good cotton duck with sound flies when properly pitched shed water even required. Not worn as a cape, it may enclose the blanket-roll or lie folded on the knapsack. The material is strong, light cotton, water-proofed with lanolin, permeable to air and not subject to mildew. It weighs five pounds. As either tent or cape it probably will be efficient. Difficulty will arise when a man on duty in a severe rain must transform his tent into a water-proof cape or cloak. This might be avoided if it could be arranged that two men should always tent together and that both would not require to wear their capes simultaneously.

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The best military tents are made of cotton duck, which is permeable to air when dry and whose fibres when wet swell sufficiently to exclude ordinary rain. Tents of good cotton duck with sound flies when properly pitched shed water even in heavy storms. Linen duck, which has been used in exceptional circumstances, allows heavy rain to soak through.

Tentage

But water may pass by conduction through any saturated canvas when a solid body is in contact, or when it settles in hollows in the roof.

Pitching

It is an elementary lesson in camp life, frequently marking the condition that makes for comfort or discomfort, which new troops sometimes acquire only by experience, that the cords must be loosened, not cast off, when it rains, lest their contraction when wet should draw the pins; and conversely they should be tightened as they dry after the rain. Where the dew is very heavy, to avoid annoyance this must be done regularly night and morning. The pins that hold the cords should in most soils be set nearly parallel to the pitch of the roof or of the fly, and not at an opposing angle as recruits incline to attempt. In order that the roof may not catch water as well as for appearance sake, tents should always be pitched smoothly and carefully.

Color

For military reasons all canvas, including wagon covers, should be tan or drab in color; which is also a hygienic advantage, in that such a tent is less attractive to flies than one that is glaring white.

Ventilation

Dry canvas is freely permeable by air, but when it is wet, although rain will be excluded the saturated and swollen fibres prevent the interchange of gases with the outer air and confine the aërial organic particles, so that a closed wet tent when occupied speedily becomes offensive to the sense of smell and poisonous to the inmates. Wet or dry, even allowing for probable absentees, as the official assignment of enlisted men to all but the shelter tents is too great for permanent occupation, pains should always be taken to insure ventilation, even at some expense of heat.

Heating

But the temperature of any tent may be made comfortable by a handful of coals from a camp-fire in a little excavation in the earthen floor. With a wooden floor of course this is impracticable. The conical tents are expressly arranged for artificial heat, but any variety of wall tent can use the sheet-iron field stove safely only in connection with Davis's asbestos collar or some similar device. No tent is properly pitched until it is ditched. The tent ditch should be six inches wide (or the width of the spade) by four inches deep directly at the base of the wall, and the earth should be thrown upon the sod-cloth, or towards the tent if the walls are not lowered. The object is not to drain the tent but to prevent rain-water entering it. This ditch from its lowest point should follow the natural slope of the ground into the company ditch. If the tent stands on a natural slope there need be no ditch on the lower side. To ditch every tent invariably and immediately, regardless of the appearance of the weather (the California summer excepted), should never be omitted, for the habit is valuable to acquire and its neglect may lead to flooding from sudden rain. The company streets and other spaces are to be promptly laid out and a careful system of drainage arranged, certainly not later than the second day, for very little camp labor is more profitable.

Ditching

Tactical considerations permitting, tents should open to the east so that they may be flooded with the early sunlight. The tent walls should be raised for several hours every fair day, all the bedding and the coverings, if any, over the floor be withdrawn and exposed to the sun, and every particle of refuse removed and if possible burned. When the weather permits, the leeward side of the tents may be raised at night. If floored, every board should be loose and be removed frequently and the ground beneath cleansed. A fixed floor is neater in appearance, but waste matter will work beneath and cannot be reached. The constant temptation to conceal articles under loose floor boards is to be controlled by vigilant inspection. In a fixed camp wall tents in particular may be gratefully protected from the summer sun and additional sheltered space may be gained occasionally, by throwing up light booths of branches above

The general economy of tent life

and in front of the tents. Very trifling supervision will prevent excess or the appearance of disorder, and the relief from torrid rays compensates for the moderate labor and slight attention that are necessary. Every tent should have adjacent to it at least an equal, and by preference a double, vacant area in addition to the company street, and be changed to the alternate site every week or ten days, and the old site be scraped and exposed to the sun. Care should be taken that the inter-tent spaces are not walked over unnecessarily or defiled. When practicable, the entire camp should occasionally be moved if only a few hundred yards, better a greater distance, to fresh soil. Permanent camps should be as open or widespread as possible, for the evils of overcrowding and the necessity for fresh air, the want of ventilation, and the accumulation of débris increase directly with the size of the command. Occasionally there is a specious but unreal expansion, as when a division or a corps spreads over a wide area while the regimental camps are condensed and crowded. Undue crowding of men within company or regimental lines is not compensated by vast intervening spaces for exercise or drill.

Log bases and excavations

In camps of any permanence, especially in cool weather, log walls from a few inches to several feet high, chinked with mud, are often raised and the shelter tents used as roofs; and in camps of position in the winter soldiers are tempted to burrow for warmth. Negro troops are particularly prone to such undermining. Neither the walls nor the cellars can be shifted and in both their internal police must be the more carefully enforced. Excavation is usually deleterious from the tendency of gases of decomposition below the frost line to drift laterally into these as into other cellars, and sometimes from dampness. Occasionally it may be tolerated in very pure and dry soil, but the question should be determined by examination in advance and be controlled by orders.

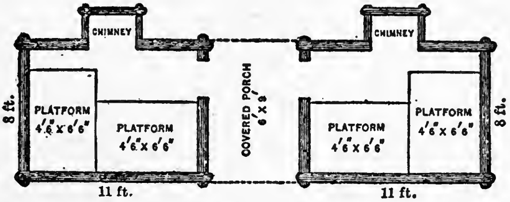
Where timber is available the best camps of position, or

Huts

Smart's hut

Squad huts

cantonments, are huts. The late Colonel Smart, of the Medical Department of the army, suggested a modification of the practice in the Army of the Potomac as follows: Inside area 13 by 7 feet, to the eaves 6 feet, to the ridge 10 feet, with a door in the middle of one long side and a chimney directly opposite but outside the wall. There would be a double bunk on each side of the doorway. There should be a canvas roof 14 by 12 feet with a larger fly, both detachable for transportation. This hut is large enough, for an increase in size in any direction would mean more inmates and relative crowding. A better arrangement for squads of eight, the drill unit for offence, would be two huts each 8 by 11 feet in the clear, 6 feet to the eaves, and 10 feet to the ridge, standing end to end 6 feet apart with doors in the adjacent ends opening upon a communicating porch or platform, the whole to be covered by one continuous canvas or other roof. If the roof is of canvas there should also be a fly. Each of the pair should have two platforms, 6 feet 6 inches by 4 feet 6 inches, one lengthwise and one across the end. These platforms would accommodate two men apiece lying with their heads adjacent. The covered intermediate porch would be 6 feet by 9 feet in the clear, the sleeping-platforms to be open beneath, and under no pretence should two-story bunks be allowed. In the absence of timber, adobe walls or wattle plastered with clay are available for these huts. The minimum space between huts in the same row should equal the height of the walls, and the passage in the rear should equal



Ground Plan of Squad Huts for Four, each with Covered Porch.

the height of the ridge. The intervening spaces should always be carefully policed, for pollution there will ultimately defile the air that is drawn into the huts. All ordinary refuse should be burned, if military considerations permit. Otherwise it must be removed where it will not be offensive to any camp, or be buried. Hut sites are to be well rammed and to be ditched as with tents, for the health of the inmates. Company streets should be thoroughly drained, because dry streets are important for company formations, and the whole camp ground be systematically freed from dust and moisture alike. In the peace camps for manœuvres and instruction the application of crude mineral oil has been found to keep down the dust and to be deterrent to flies. A wet or even a moist camp will soon be trampled into a mire, from which the ground-air may take up poisons.

Policing

Abandoned camp-grounds are always liable to be foci of disease and are never to be reoccupied. So with a deserted cantonment of huts, however tempting such shelter may appear. Only the most vital exigency allows this general and imperative rule to be disregarded. The one exception is a camp of instruction maintained from year to year and elaborately provided with systems of pure water and with sanitary conservancy. These may be revisited indefinitely without harm as long as the prescribed precautions are observed, for they are military camps only nominally. That is from the sanitary view-point they are such only in name. As seminaries of practical information in the minor movements of troops they excel. They also exemplify a sanitary ideal and are object-lessons of a perfection impossible of attainment in the field of war, but always to be sought for there. There is some danger that these valuable centres of tactical instruction and of the rudiments of life under canvas may be so completely misunderstood as representing the possibilities of warfare, as to lead to unmerited censure on the one hand and despair on the other when armies are collected for active service.

Old camps

Camps of instruction

Occupation and amusement

In fixed camps and also in garrison constant occupation and reasonable amusement are indispensable for health and efficiency. A marching column is always healthy, and the sick-list grows with the age of the camp. Excursions beyond the camp lines, reconnoissances in form or in fact, problem marches in peace, reconnoitring in war, have a marked sanitary advantage in stimulating the mind and developing the body, rendered stagnant and inactive by ceaseless routine with no appreciable result, as well as by the more immediate military interest they arouse and the technical instruction they supply. In all winter camps systematic efforts to amuse the men are important. These may include dramatic, minstrel, and vaudeville entertainments by the men themselves, vigorous athletic games in which numbers join, lectures by officers on practical subjects, and especially music. Martial music particularly appeals to most men, and good bands are not only good hygienic agents but when bands are suppressed, as sometimes happens, the whole command loses heart. The dreary monotony of winter camps, the limited quarters, poor opportunities for cleanliness, indifferent light, long evenings and delayed dawns, are wretchedly depressing and lead the unstable nervous equilibrium to seek relief through the abuse of cards, tobacco, and alcohol. This tendency, which in a minor degree also pervades the garrisons of posts, should be constantly remembered, and if an efficient and hopeful command is to be maintained the horrible *ennui* must be dissipated.

XXV

CONSERVANCY IN CAMP AND GARRISON

Conservancy

Danger from excreta

Conservancy is the technical military term for the disposition of waste, which is so serious a sanitary problem at permanent posts and in the field. That waste which follows the mere act of living is a necessary accompaniment of animal existence. All body-waste is offensive and some of it is actually harmful, and its disposal is a serious problem which increases in complexity with the size of the command and the time that a position is occupied. The care of garbage and other rapidly accumulating refuse is a minor but important phase of the same question. Human waste should be properly and promptly cared for on two accounts, its inherent filthiness and the risk of infection. Cholera, for instance, is propagated by the discharges of the ill, not merely through contaminated water but by accidental contact with the mouth in other ways. This is also true of some forms of dysentery and perhaps of some diarrhœas. Typhoid fever owes its spread to the intestinal and, in a degree, to the urinary discharges from not merely the ill but occasionally from those who are apparently well, as will be explained later. Now it is true that cholera is not a common disease and infective dysentery is relatively rare, but one of the objects of military discipline is to accustom men to do habitually and as a matter of course and without special direction those things which make for efficiency. The drill of mind and body that transforms the civilian into the soldier is not postponed until the day of battle. Sanitary drill as part of a soldier's education should not be deferred until an epidemic is upon us, but should make the men automata in the habitual practice of everything that pertains to decency and health. Nothing so directly marks ill-disciplined troops as soil-pollution from human waste.

Sinks

The first duty on halting for the day is to post sentinels over the water-supply and to designate a place at which to attend to the calls of nature. Sinks, sometimes mistermed latrines (which implies the presence of water), are to be prepared with the first tools. The pioneers' spades and axes would be most profitably used thus at once; but in the absence of pioneers, intrenching tools will serve. The only exception to the rule for the immediate preparation of sinks is when the command is very small, goes into bivouac after dark, is certain to march the next day, and it is known that none will follow. Even then the men must use a specified area, and when the command moves a police party should carefully cover the deposits. On the march the calls of nature must be attended to, and it is customary to halt, partly for this purpose, after half an hour's advance. The formation of a long column must be respected, and all the men cannot be concentrated; but smaller units may use one neighborhood and all who leave the ranks should be required to resort to the same side of the road, preferably the leeward. All such waste must be carefully covered, if not by the man himself with the squad's intrenching spade, then by a fatigue party under a non-commissioned officer. In the tropics this may be done by a native working-party, if attached, similarly supervised. The injunction, sometimes given, to scrape loose earth with the foot or the bayonet over the excreta, is bad; for these may become contaminated in the very effort, so that the man would carry the pollution along with him. The importance of not indiscriminately defiling the roadside is so great that the order for the day's march should announce the flank to be used for this purpose, and the regimental officers should see that the order is obeyed. The officer of the day or of the guard should be responsible for the proper covering of

On the march

the excreta. When the men understand that neglect of those precautions may embarrass those who follow, may seriously trouble a friendly countryside, may prove a nuisance to themselves countermarching, and at any time may spread disease, decent soldiery will willingly coöperate. Officers who appreciate the significance of the situation will not allow the disagreeable nature of the duty to interfere with its strict discharge.

Emergency sink

Camps, even bivouacs, may distinctly differ in peace and in war. The bivouac of a command on an undisturbed practice march or a change of station may be very unlike one in the presence of the enemy, or in pursuit or retreat. But they have this in common: the water-supply must be guarded and sinks provided. For a large or a somewhat stable command, this provision should be identical with those in camps. For a detachment, especially for one in transit, the simplest device is that advocated by Lieut. Col. Firth, R.A.M.C., which may be called the emergency sink. It is a row of short trenches not more than three feet apart, each two feet deep, three feet long, and one foot wide, to be used by only one person at a time, which the man bestrides without occasion to befoul the sides. If the removed earth is properly preserved, these may readily be filled and fresh ones opened as required. Sinks of the same type, not more than a foot deep, may very properly be dug behind a temporary or other screen at the noon halt on a march, to be filled on departure.

Camps are of two kinds: for instruction in peace and for active service in war. Besides discharging their proclaimed purpose, camps of instruction are admirable in demonstrating that, certain precautions being observed, thousands of men may live under canvas for weeks without becoming ill from conditions induced by each other's presence. And what is true of these mixed camps of regulars and National Guardsmen may become approximately true of camps of concentration in impending war. For fixed camps the Quartermaster's

Department supplies certain mechanical contrivances in lieu of sinks. A convenient form is the Reed pattern. This is a galvanized-iron trough forming a latrine that holds water and crude petroleum, whose contents are pumped daily, or oftener, into an odorless wheeled tank, to be emptied into a ravine or artificial pit at a suitable distance. That should have seats and covers, although it may be used without either. The excreta should be the only waste it receives. The object of the crude petroleum is for disinfection and to banish the flies, the importance of which will appear later. As a mechanical contrivance may become deranged or broken, so it is found with this that solid matter, including insoluble paper, may clog the pipes, and that the petroleum decays the rubber or leather valves, a minute rift in which destroys suction. As the petroleum is too important to be relinquished, the valves should be metallic. The working allowance of this apparatus is one standard trough for two companies and one wheeled excavator for 1400 men, with spare parts and an occasional extra machine for emergencies. As no such apparatus can be automatic, much of its efficiency depends upon the intelligence and care with which it is managed. Ordinarily the excavator cart will be manipulated by Quartermaster's employees or by men of a Service Corps. Besides, a man (by preference from the organization using it) must be present when the trough is emptied; he should introduce water three inches deep at the higher end, spread a pint of crude oil over this water, maintain a supply of toilet paper at the latrine, and keep the interior and the surroundings scrupulously clean. Disagreeable as such care of the apparatus may seem at first, it should be possible, through the intelligent interest and encouragement of the officers, for the men to realize that such duty is preventive of disease and conducive to decency and is as honorable and more effective than some other forms of fatigue. It should never be degraded as merely work for prisoners, but

Reed trough latrine

Care of troughs

Importance of this duty

this and the kindred duty of the care of the field sinks may well be made into tours of a few hours each. It is legitimate and important orderly duty. If officers discredit it, the men will slight it; if they dignify the work and insist upon its importance, the men will respond. Company officers should constantly remember that the art of military sanitation, upon which the vigor if not the very existence of an army may depend, is the resultant of independent but correlated activities, and that the great achievement of keeping a command free from disease requires the proper exercise of all of them. Should this work be laid on civilian laborers, they must be held to a strict and unremitting responsibility. Admirable as these appliances are for a field camp, or for a moderate command whose movements are leisurely and pre-determined, their availability diminishes directly as the size and activity of the field forces increase. They simply cannot be at hand when wanted, so that the nearer a column is to a hostile front the more inapplicable are they for its needs, and the wider and more rapid the military operations by so much must these be left behind. This is even more the case with the portable earth-closets whose contents are transferred by hand, sometimes issued in the eastern islands. The odorless tank, which is in the nature of a movable water-closet, requires the soluble toilet paper now furnished by the Subsistence department. For economy's sake, as well as to avoid sullying the appearance of the camp through loose pieces blowing about, the paper should be supplied in rolls, not in sheets. It is still more important to insist upon the use of soluble paper in the permanent plumbing now generally installed in posts, which ignorant recruits are so liable to derange with newspaper, bits of cloth, and sometimes with more unsuitable objects.

Unsuited for large and active commands

Toilet paper

Incinerators for the disposal of excreta are not yet sufficiently developed to be odorless, or of capacity to be available without undue multiplication. It is therefore necessary to be

Incinerators

Trench sinks

familiar with and on occasion to revert to the more primitive methods of the field. This question of sinks is one of the most important and perplexing in field hygiene. Sometimes the underlying rock, at others the height of the ground-water, prevents making deep trenches. Nothing then remains but to use shallow ditches, shallow by necessity and design, to keep regiments far apart, and to make new sinks frequently until formal and efficient apparatus replaces them or the camp moves. Sinks should not be in the course of winds that usually blow toward the camp, although some portion of a large command may be affected by ill-kept sinks in any situation. There must always be care that they cannot pollute the water-supply by overflow or soakage. The typical and most useful field sink (as distinct from apparatus) is a trench 2 feet wide at the top, 12 to 20 feet long, at least 3 feet deep and as much deeper as may be convenient. There should be a stout pole, supported at a convenient height by forks, as a seat. In a small or individual sink a box seat open at the rear is admirable. The earth dug from the trench should be thrown to the rear, and in the best camps the sod will be preserved to be replaced when the pit is refilled. Each evacuation should be covered from the pile of earth with a shovel that should always be at hand, and a thin layer of fresh earth be spread over the whole several times a day. The mistake should not be made of supposing the smell is the chief evil to be overcome. By itself the odor is of little importance except as an advertisement. The real mischief is by the conveyance of minute infectious particles among the men by insects and on the clothing or the hands of the men themselves. When available quick-lime is a cheap and valuable disinfectant, but it should not be used at all in the Reed troughs on account of its action on the excavator hose. Crude petroleum is better and when procurable should be freely, not wastefully, employed. Otherwise, and sometimes in addition, newspaper or straw sprinkled with mineral oil may be freely burned at the bottom of the sink. A serious and frequent evil is the foulness of the rear wall, in which case the sink should be widened or that surface be drenched with oil and fired. The ground in front of the trench is liable to become soaked with urine, against which men should be cautioned, in part for reasons to be given later and in part because of the mire that is apt to follow. Should there be risk of such pollution loose stones or wood should be laid along the edge. Sinks should be screened with brush and usually covered overhead. When enclosed with canvas, as sometimes in fixed camps, the color should be dark, not light, on account of the flies. At night the sink should be lighted by a lantern. The administration of these necessary adjuncts is extremely difficult, chiefly because its importance is not generally appreciated. Officers and men who with perfect fidelity would protect a front by outpost and picket duty in the worst of weather, shrink from what is equally a service of defence and sometimes is more vital. Until the line realizes how some serious diseases are spread and coöperates intelligently in limiting their diffusion, these will continue to ravage their commands; for the artificial safeguards of the camps of manœuvre cannot be invoked under the conditions of war. Hence the sanitary police of company sinks must be controlled by the organizations that use them, subject to general administrative supervision. Besides their stated sanitary inspection, the officer of the day should include and critically observe them in his formal rounds and a corporal or lance corporal should justify his chevron by enforcing obedience to their regulations. The proportion of sink accommodation to the command should be, in yards, about 8 per cent. of the number of men; that is, to every hundred men about 24 feet of trench. Every sink should be carefully filled in, and preferably sodded, when the contents are a foot from the level of the ground. As far as possible the earth thrown in should be pulverized, and the site of every such sink should be carefully marked for the information of succeeding commands.

Administration of sinks

The disposal of urine is another care, partly because it is offensive and partly because disease-causing bacteria are sometimes voided with it. In the day it is better that the sinks or latrines, if not too distant, should be used. When they are too far for convenience, the English make a pit 3 feet deep by 2 feet in diameter and fill it with large irregular stones. Two or more shallow trenches roughly paved, a foot wide and 6 feet long, lead at a slight grade to the pit, and into these, not into the pit itself, the men pass water. This urinal should be screened and may be established anywhere subject to ordinary sanitary judgment. It is useless to expect men to go a considerable distance at night for such relief, and urine tubs should be placed within or at the end of the company streets. The best are galvanized-iron cans, those for a regiment being nested by fours for convenience of transportation. Lanterns should mark them at night. Practicable receptacles may be extemporized from tight half-barrels, oil cans, and other retainers of no intrinsic value which may easily be discarded. These vessels should be removed at reveille, scrubbed out with crude oil, and exposed all day to the sun and air. They are better placed upon slight wooden platforms, which help to preserve the soil from pollution and may be burned when no longer fit for use or the camp is broken up. Urination within the limits of the camp elsewhere than at the designated places, should be looked upon as a serious misdemeanor.

Urinals

Besides the body-waste which is immediately offensive and should always be treated as dangerous, whether specifically so or not, there are organic refuse, vegetable and animal, from the kitchens and eating-places, litter and manure of the picket-lines and stables, offal when animals are slaughtered near camp, carcasses of horses and mules dying from disease or injury, and the heterogeneous rubbish, ranging from tin cans and worn-out equipment to the fragments of clothing, boxes, and paper which multiply

General refuse

Fire and its management

in a camp of any continuance and must be disposed of for the sake of order if not of decency. It is true that common refuse does not in itself cause disease, else our cities would long ago have been depopulated. But as some diseases thrive because of the presence of refuse and as it is impracticable to discriminate between the harmless and the harmful, to tolerate one would abet the other; and at all times neatness of place as well as cleanliness of person are military virtues to be cultivated for their own sakes. Fire is the natural and immemorial purifier, which equally destroys visible waste and possible sources of disease. The only legitimate objection to its use is that it may be a tell-tale. The observation of habitual fires affords an estimate of strength, and clouds of smoke, which unwary officers sometimes permit to be made on breaking camp, convey significant information to intelligent scouts and sometimes signal for many miles across the country the abandonment of a position. Desirable as it is to leave no débris on an old camp-ground, it is more important not thus to advertise an impending movement. In very dry situations it is a quasi-sanitary care to make sure that camp fires do not ravage grass or forests, to say nothing of tents and stores. Every fire in open field or forest should be extinguished before its guard withdraws. In some forests the fire creeps along the surface of the soil under the superficial leaves and mould, breaking out at a distance. In such regions every fire should be guarded by a wide ditch around its base, to prevent it from spreading.

Kitchen sinks

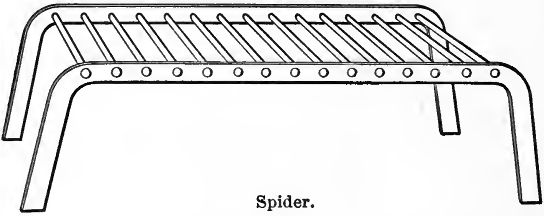
The primitive disposal of kitchen waste is by soakage of the liquids in an artificial pit, while solid matter is put in a box or barrel for removal by a police party. The savage leaves such waste directly on the surface. The company kitchen should be promptly established and, if but for a night, it should occupy the same relative position as if the camp were to persist for a month. As soon as the kitchen is designated, the sinks should be dug, to the leeward if possible and relatively near. In even the most temporary camp slops should not be thrown over the ground, as careless civilians defile their kitchen yards. In a camp of some duration where fire cannot be used, the open sink should give way to a large deep pit, roofed with timber and densely covered with earth to exclude atmospheric heat, accessible only through a small trap-door. In all but clay soils liquids slowly drain away, putrescence always is delayed by the comparative coolness, and flies avoid the dark interior even when there is an open way. Where squads or single men make individual cook-fires on the march habits of neatness should be equally developed, and if the ground is occupied after the meal all organic remains should be carefully cleared away. When a water-soaked soil makes sinks impossible, shallow trenches may temporarily drain off liquid waste, trusting to soakage and to sprinkling with crude oil if available; and garbage may be carefully covered with fresh earth and with quick-lime if at hand, above or below the level of the ground. The essential object is to avoid exposing organic remains to flies.

Fire-pit

Where a camp is to last longer than a day or two and stone is accessible, an old-fashioned fire-pit should be made. A typical fire-pit is from three to five feet deep, circular, fifteen feet in diameter. It is paved with loose stones and the circumference is lined with stone or brick laid dry and carried up 12 or 15 inches above the level of the surface. Against this upper wall enough excavated earth is packed to prevent surface water running in, and at one or two points an incline is arranged for carts to back upon. In the centre is a cone of large stones whose purpose is to create a draught. This is essential. A brisk fire is started with wood laid cross-wise half way around the bottom. When this burns fiercely all sorts of garbage may be rapidly consumed. The water evaporates and the solid refuse offers itself as fuel. The stones become so hot as materially to aid in the desiccation and destruction of the waste. Where stones are not available, Firth suggests stacks of old cans upon which rubbish may be piled and fired, the openings between the cans supplying air. The same tins may be used repeatedly, but they do not retain heat as well as the stones. The English sometimes use a device that consists of: (1) Two trenches which intersect at a right angle, to supply air. These should be the width of a spade, six to nine inches deep, and five or more feet in length. (2) At the intersection an extemporized iron grating, as of rails or bars, upon low supports. (3) A sod or clay-and-stick chimney, rising from the intersection. A brisk fire at the bottom of the chimney is fed with fuel and refuse from the top. The constant attention that this requires is inconvenient. A valuable improvement over the large fire-pit is the kitchen crematory brought into notice by Arnold, of the Pennsylvania National Guard, under the name of the spider crematory. A spider is a framework of iron bars four to six inches apart, riveted into side pieces whose ends are bent downward at a right angle to form legs and hold the frame sixteen to eighteen inches above the ground. On it may be done all the company cooking except baking and roasting. It is so simple and so strong that it may easily be transported without damage, and although not a part of the formal issue it may be obtained through the company fund. To use it as a destructor a pit is dug sixty inches long, thirty inches wide, forty-eight inches deep at one end and thirty-six at the other. This is filled loosely with tolerably large stones to a

Small field crematory

Spider crematory



Spider.

height a few inches above the ground level and it is banked up all around sufficiently to exclude surface water. The spider is then set on the stones and a wall of stones, sod, or cord-wood is continued front and rear to the top of the spider, both ends being left open for draught. Fire is built under the spider on top of the stones, and by the time the meal is served there is a very hot fire needed only for heating water. The hot embers continually heat the stones they rest on, and these in turn heat those next below. The garbage to be consumed is laid at each side of the central fire, and as it becomes desiccated it may be pushed into the flame and consumed. Incombustible material is purified for removal to a proper place of deposit. Dish-water, coffee grounds, and other liquids are poured in carefully at the deeper end of the pit, where a part is evaporated by the heat of the stones and a part drains away. The spider crematory is successfully used in the encampments of the Pennsylvania National Guard, and the public is indebted to Major H. A. Arnold, of that service, for its becoming more generally known. It is unnecessary to make more than a shallow pit for an overnight camp. The great advantage of this device is that it disposes of the garbage of each company kitchen practically *in situ*, without delay and apparently effectually. The Conley garbage consumer is a travelling substitute for the fire-pit which, as far as tested, is pronounced admirable and its operation to be less costly than that of the pit. It warrants favorable consideration until prolonged tests on a large scale definitely determine its fitness. But all movable apparatus to accompany mobile columns is open to the objection of probable absence when required and occasional breakage when not easily repaired. In winter quarters, camps of concentration, and at other fixed positions as permanent posts, regular garbage destructors may properly be built with the care their usefulness warrants. In those camps where water is piped shower baths are arranged, and in every

Conley garbage consumer

Fixed destructors

Waste water

Picket-lines

Wagon trains

camp the men should be able to wash their clothing. The better plan to dispose of this waste seems to require pits of considerable depth filled with large stones and covered loosely with boards, into which after use the bathing water flows and the washing water may be poured. Waste water should never be allowed to flow over the surface of the ground, where it always makes mire and occasionally is specifically harmful. In all camps care should be observed about the droppings of horses where flies are most apt to breed, because some infectious diseases are in part transmitted by these insects, as will be explained later. On active service the cavalry and artillery horses must be near the men, but in fixed camps the picket-lines or stables may be more distant. In both cases with proper sanitary police the risk from flies may be substantially eliminated, but like all other sanitary measures this requires constant vigilance and clear recognition of its necessity. Greater difficulty attends the care of the corrals and parks of the wagon trains, where the hired teamsters observe a very shadowy discipline; and usually there is little recognition of their sanitary relation to the organized forces or of the importance of sanitation to the men themselves. Nothing can be done with these trains and their teamsters without the incessant coöperation of the Quartermaster's Department, which is usually too short-handed in appreciative officers.

Sewage and sewerage

Sewer and drain

In the conservancy of a permanent post the same principles are involved as in that of a camp, but the methods more nearly resemble those of a town. For convenience a few definitions of the commoner agencies and conditions are presented here. Thus: Sewage is the waste of inhabited places, and sewerage is the system of water-carriage by which it is removed. Careless writers sometimes confuse these terms. A sewer is a conduit for the removal of waste, generally meaning excrementitious waste, and a drain is a channel

House-drain

Soil-pipe and waste-pipe

Ventilating-pipe and vent-pipe

Separate and combined sewers

Sewer-air

Water-closet, seal, trap

for the escape of surface or subsoil water. But house-drains are those which carry kitchen slops or laundry water out of the house. In this country "house-drain" is rarely applied to sewer connections, as it sometimes is abroad. The soil-pipe is the fixed upright pipe into which the water-closets empty through waste-pipes within the house, and which out of the house connects directly with the sewer. The ventilating-pipe is the upward extension of the open soil-pipe above the highest water-closet into the air. The vent-pipe is a smaller pipe, sometimes used to admit air into the trap. A ventilating-pipe and a vent-pipe have distinct functions. The separate system of sewerage is that which carries only sewage, and the combined system carries sewage and storm-water together. Sewer-air, a better term than sewer gas, represents air contaminated with emanations from the solid contents of sewers, either in bulk or as lining the pipes. A water-closet is an apparatus for the immediate removal by water of excrementitious waste from the place of deposit, commonly within a dwelling. A seal is a barrier, usually of water, designed to prevent the upward passage of sewer-air, and a trap is a mechanism to retain the seal in position. An earth-closet is essentially a portable receptacle where the discharges are promptly covered with dry earth and the vessel is emptied at frequent intervals.

Sewers

A sewer that conveys storm-water as well as sewage should be egg-shaped in section, the small end down. Otherwise a pipe designed, as it should be, to carry the maximum flow would not be nearly filled during much of the time, so that when sewage alone is passing the solid matter would lie stranded in bars because of an insufficiency of liquid to carry it forward. But separate sewers should be circular in section, for economy in material and efficiency of service. They should be just large enough to carry the estimated sewage and small enough to be completely flushed by it. Sewers are to be carefully laid on solid foundations so as not to be disturbed by settling, and should be securely water-tight. A leaky sewer may be a serious evil. But pipes intended only for storm-water are sometimes laid open like an ordinary under-drain, in order to dry the ground in the intervals between rains. There is no danger of serious leakage from a properly laid drain, and on the other hand it will take up water from the surrounding soil. For military posts the combined system ordinarily is inappropriate. Where the outlet of a sewer is below high water and thus liable to be temporarily closed by the tide, there must be special provision for its ventilation; otherwise the contained air may be driven back into the habitations. The smaller the waste-pipes and the house-drains that have sufficient capacity, the more efficient they are; because the friction is less, and the greater the pressure the greater the velocity with the less chance of obstructive blocking.

Waste-pipes Waste-pipes for single fixtures need not exceed 1½ inches and should not exceed 2 inches in diameter. A diameter of 3 to 3½ inches is ample for a soil-pipe, when it is remembered how rapidly the area of a circle increases with an increase of the radius. The outlets of all waste-pipes should be of full bore, and they should join the main soil-pipe at an acute angle.

Water-closet A water-closet is a bowl, with a waste-pipe which leads directly to a soil-pipe and a supply-pipe connected with an individual water-tank. It is supplied with water to receive and to carry off its contents, and with a trap and seal in close proximity to bar the sewer-air. If the water-closet bowl is clean above the seal and the seal is of sufficient depth and is kept intact, the house is considered safe. But ventilation and disconnection, to be mentioned later, are important auxiliaries to divert the products of decomposition. Mechanical water-closets are the "pan," the "valve," and the "plunger"; they all are bad, and are noted only to be condemned. These are relics of early styles, multitudes of which are in older houses which may be temporarily used as quarters, but none should be introduced anew. Of these the "pan" closet is the worst. It receives its name from a shallow metal dish or pan at the bottom of the bowl, which receives the deposit and is supposed to discharge it on being turned half over by drawing up an attached rod. This closet never contains or receives sufficient water, the pan itself and the container are continually smeared with excrement, and there is a recess into which the pan is drawn back, necessarily foul, from which foul odors enter the apartment whenever the closet is used. This has been aptly designated a chamber of horrors, and it should be tolerated in no dwelling. The "valve" closet is a little better, but is of the same objectionable type. A valve or plug in the bottom of the bowl is withdrawn like the pan, and is presumed to be washed by the flow of water. The receiver of this closet is of better shape and smaller, it holds a greater volume of water, and the valve itself is less apt to become so foul; but the retained water is liable to escape by leakage around the valve, and the style is bad and should not be used. The "plunger" closet is less objectionable. In this a piston at one side of the bottom of the bowl retains the water until it is raised to allow the contents to escape. But this mechanical appliance is liable to be smeared and to defile the atmosphere, and sometimes it is clogged in such a manner that the retained water oozes away. The "hopper" closets, long and short, have no movable machinery and are plain bottomless bowls set upon a trap that opens directly into or is a part of the soil-pipe, the water that clears out the hopper entering by a rim-flush from an overhead tank. The chief objection to the hoppers is that the walls may be so soiled that the ordinary flush will not cleanse them. This may be partly obviated by flushing the closet before as well as after use.

Pan closet

Valve closet

Plunger closet

Hopper closets

The short hopper is the better of the two for use within the house, because the level of the seal is nearer the seat and the trap is in view. For out-houses the long hopper is preferable, because the exposure of the trap to frost is less. But neither can be set in severe climates where there is no artificial heat. Acceptable modern closets, such as alone should be introduced in officers' quarters, are known as "wash-down" and "wash-out," where the bowl holds a moderate depth of water and a deep seal lies below. A rim-flush sweeps out the contents with sufficient force to send everything through the trap. There are several forms of siphon closets, which are an improved variety of these. In one a jet is thrown from the front wall. In a second the trap is baked into the bowl as a part of it, and both receiver and seal contain several inches of water. When the outflow is started by the flush it is impeded by a constriction, so that the long arm of the siphon quickly forms and all the contents of the basin are exhausted. A third is operated by a column of water from the flushing-tank held in position by atmospheric pressure with the end in the water of the receiver. When the cistern discharges the descending water escapes through the flushing-rim and by way of the siphon. The back of the receiver is less liable to become soiled when it is nearly vertical or retires to the rear, than when it is conical and sloping forward as in some patterns. Every closet should have its individual flushing-tank, to avoid contamination of the drinking supply. The delivery pipe should be at least $1\frac{1}{4}$ inches in diameter and the fall be not less than 4 feet to secure an adequate head. A competent flush requires three gallons of water, which should be by the rim to scour the bowl. It is no economy to use too little. A variety of the siphon closet known as "silent," where the tank is almost at the level of the seat and a larger outlet compensates for the decreased head, is acceptable in as far as less noise accompanies its operation. But there is a risk of

Wash-down and wash-out closets

Siphon closets

Flushing-tank

Silent closet

insufficient force from inadequate head. Direct connection with the house water-supply, to which there is a tendency in order to secure pressure, should be guarded against for fear of contamination if the apparatus should get out of order.

Fixtures exposed

Urinals

Public closets

Common trough

Water-closet fixtures are to be freely exposed to view for inspection and never to be boxed in. The pipes should be neatly painted and not be concealed; at the most the covers may be screwed, not nailed, on. Urinals should be allowed in dwellings under no circumstances. It is impossible to keep them free from ammoniacal odor which will diffuse itself, and when insufficiently flushed toxic bacteria may abound. For public buildings with closets in frequent use copious automatic flushes arranged to discharge at regular intervals are safer than those depending upon individual care at the time. For troops in garrison latrines should be in detached buildings heated above frost, usually arranged as troughs with multiple seats, having an automatic flush to be set for such intervals as desired. These troughs should be wide enough for the rear wall not to be soiled by diarrhœal discharges. A primitive trough whose contents escape after the removal of a plug at the lower end is sometimes used, but is unsatisfactory. It retains several inches of water when the plug is in place.

Seats

Care of latrines

A common error in making water-closet seats is for the opening to be too wide. For physiological reasons the buttocks should not be caught between the borders, but rather should rest upon the sides of the seats. Recruits, many of whom are entirely unfamiliar with such conveniences, should be instructed in the use of toilet paper supplied in rolls, not sheets, and they should be warned against the mischief, which should be explained, that may follow introducing insoluble objects. When it is understood that, if the culprit is not discovered, damage from careless use of latrines will be charged *pro rata* against the organization, there will be greater

Wooden conduits

interest in their care. A well-kept latrine is so great a convenience that harm usually comes to it through ignorance rather than by design; so that it is good administration for its operation to be frequently and carefully explained. The latrines should be rigidly inspected every day. It occasionally happens that, through insufficient appropriations or otherwise, post authorities use wooden conduits through which to discharge water-borne excreta. In a short time these become clogged and saturated with their contents and are thus transformed into elongated cesspools. If used at all, they must be set so that one angle well calked with white lead forms the lowest line and that the grade is heavy and uniform. At the best this is but a poor and temporary expedient.

Control of sewer-air

Having secured a closet that will discharge its contents without polluting itself, the next requirement is to prevent the sewer-air always present in the pipes from escaping through the water-closet into the dwelling. Emanations from fresh and healthful fæcal matter, however unpleasant, do not appear to be intrinsically mischievous; and it is not probable that the bacterial causes of specific diseases are disseminated within dwellings in this way. Bacteria have no independent power of locomotion through the air or otherwise, but must be transported upon or with minute portions of dust or fragments of organic matter. It does appear, however, that air seriously charged with the putrefying products of organic waste when habitually breathed diminishes the power to resist illness, and that inmates of houses thus polluted succumb more easily than others to attacks of disease, if indeed they do not become actually predisposed to such infection. This refers simply to sewer-air, not to the infectious particles of communicable disease-causes diffused through a house by the ill.

Seal

Now the invasion of sewer-air cannot take place if the seal, that is the water held in the trap between the bowl and the upper part of the waste-pipe, is complete and the trap itself, or the bend in the fixtures which contains the seal, does not become foul. The possible disadvantages of this curve which constitutes the trap are the check it may impose to the escape of refuse through it, that it may become permanently foul by long use and inattention, and that it may not always retain the seal. A competent trap should have the outlet of the bowl just above it a little larger than its inlet arm, so that there should be an excess of water when the seal is renewed; the trap itself should have no recess to be fouled; and when properly set it should be self-scouring, with a perfectly smooth inner surface, which implies a construction of earthenware or enamelled iron. The primitive trap, formerly in universal use and not yet entirely discarded as it should be, is the "D." That cannot avoid accumulating filth where the straight lines of the D cut the seal. It is mentioned only for condemnation. The commoner and permissible traps in the order of merit are the "P or ½ S," "¾ S," and "S." A running trap is a shallow U-like bend in a nearly horizontal pipe. It is not used in connection with a water-closet, but generally in the branch sewer-pipe between the house and the sewer proper. It should not be sufficiently angular to retain refuse, but should be deep enough to prevent the passage of air. Every time any trap is flushed all the contained water should be changed and a good supply of clean water be left within the trap. This point of use is frequently overlooked in the kitchen and laundry sinks, the bathtubs and the wash-basins, where the water that has been used merely escapes without a fresh supply succeeding it, so that which remains in the trap is the last that ran out of the vessel. Much of the disagreeable odor sometimes recognized about lavatory fixtures depends on decomposing soap and waste from the surface of the body accumulating thus in the overflow arm of the basin or sink because fresh water does not sweep it out. All the water-closet waste-pipes that join the soil-pipe should

Trap

Running trap

Foul traps

Direction of waste-pipes

do so at an acute angle, by Y's and not by T's, and over the shortest route possible; and to that end those conveniences should be placed very near the soil-pipe itself. Any waste-pipe that requires to be carried laterally should be along a decided grade with the fewest possible changes of course.

Forcing

A seal may be forced by the sheer momentum of the water dashing through it, it may evaporate, or it may be broken by back-pressure or by siphonage. It is possible for a considerable volume of water to be poured through a trap suddenly, as from a bucket, so that little or none remains behind. Serious evaporation is unlikely to occur where a closet is in use. But where a fixture is not being used, as when the house or a part of it is closed, the trap should be filled with a heavy oil or with glycerine. Leakage by the capillary action of threads, hair, lint, caught in the trap sometimes carries off a seal not in constant use. Back-pressure is the consequence of a heavy column of water forcing the air in the soil-pipe before it until near the bottom an abrupt bend, a narrowing, or some other obstacle to escape in front, tends to compress the air, when it will move in the direction of the least resistance up the nearest branch pipe and through the seal. To produce back-pressure the descending column must have acquired considerable velocity and there must be some impediment to the free movement of the air in front of it. The fixture whose trap is thus forced and seal is broken must therefore be near the bottom of a tall stack. Siphonage is the effect of a heavy column of water falling suddenly down a soil-pipe and thus producing a partial vacuum which, by releasing the atmospheric pressure below the seal, destroys its equilibrium and the pressure of the air within the closet, or above the seal, drives the water out. This is most apt to occur to the highest seal in a tall stack. Back-pressure and siphonage are complemental and

Evaporation

Capillary action

Back-pressure

Siphonage

both cannot occur to the same fixture. Neither will they occur in the low buildings of an ordinary military post, and they are mentioned here merely to round out the topic. A vent is a pipe running from the upper bend of the trap into either the soil-pipe or into a common vent-pipe, whose object is to admit air and thus prevent siphonage and counteract back-pressure. The vent should be of the same diameter as the trap, at least up to two inches. Vents are required chiefly in large houses or in those with complicated plumbing, and rarely at the ordinary military post. The objection to a vent is its liability to become clogged by undissolved material splashing against its connection with the trap, and its liability to evaporate the seal. To vent a waste-pipe and to ventilate a soil-pipe are distinct and disconnected operations. A widely used and satisfactory vent attached to traps connected with sinks, lavatories, etc., is the M'Clellan, which preserves the equilibrium by introducing fresh air from the interior of the building and uses mercury to prevent the backward flow. It is competent against siphonage but not always against back-pressure or momentum (forcing) in a water-closet trap.

Vent

Mercurial trap vent

The soil-pipe, which receives and conducts to the sewer all the sewage of the dwelling, should be of iron until after it leaves the house on its way to the sewer. Leaden pipes formerly used are liable to corrosion and to be gnawed by rats. Its passage through the foundation wall should be protected by an arch. This section is sometimes called the branch sewer-pipe and sometimes, but inappropriately, the house-drain. The calibre of the soil-pipe should not exceed 4 inches for large public buildings, while from 3 to 3½ inches is ample for private houses.

Soil-pipe

Calibre

Free ventilation of the soil-pipe is the second agency for securing the freedom of the atmosphere of the house from pollution by the sewer-air. The extension of the soil-pipe above the topmost closet becomes the

Ventilating-pipe

ventilating-pipe, with no obstacle from end to end excepting a possible running trap between the house and the sewer. This affords free passage for the contained sewer-air into the outer atmosphere, relieving the seals from undue pressure. In order to prevent the leakage of gases, the ventilating-pipe must be of the same material and construction as the soil-pipe, of which it is the continuation, and it must extend full calibre above the roof. In cold climates the extremity should be somewhat larger on account of the accumulation of frost, and the end should not be curved downward nor covered with a cowl. The ventilating-pipe should terminate below the level of a chimney-top to avoid a down draught, and it should be a little above the ridge to secure the advantage of aspiration. It should not be near a window into which odors from it may drift. Neither the ventilating-pipe nor the vent-pipe (if there is one) should terminate within a chimney, as sometimes advised to take advantage of the heated upward draught, because the fires are not perpetual and down draughts often occur. Interior pipes are also liable to become choked with soot. To insure a change of air, or true ventilation, there must be an inlet as well as an outlet and this is found in the disconnecting vent.

Disconnection

The third agency in regulating sewer-air in the soil-pipe is "disconnection." This is conventional rather than actual, and it is difficult to carry out in snowy climates. It requires a vent of full size in the pipe line between the house and the sewer, on the house side of the running trap, if there is one. This will allow the escape of foul air or the entrance of fresh air, as the pressure may determine; but as a rule the sewer-air will not escape by the vent, which should terminate in a bend with the mouth toward the ground, but will ascend through the warm soil-pipe. Nevertheless windows or air-ducts into the house should not be near the vent. The running-trap may be omitted when the sewer into which the soil-pipe discharges is fairly well kept, or if the grade is not good, or if it is liable to be frozen. It is more important when the sewer system is not good.

Direction of soil-pipe

Testing soil-pipe

The soil-pipe should have as few changes of direction as possible, and those over large curves, nor should it approach the horizontal if it can be avoided. When first set up in ordinary quarters this pipe should be tested by water-pressure. The lower end and the Y's for the fixtures being securely closed, the pipe is to be filled with water which should maintain its level for at least half an hour. If an aërial leak is suspected, all the traps are to be filled and several ounces of the oil of peppermint followed by two or three gallons of hot water to be poured into the top of the soil-pipe. The peppermint must not be carried through the quarters except when hermetically sealed, and the person who has handled it cannot enter the house until the condition of the pipe is determined.

Rain-leaders

Rain-leaders sometimes conduct storm-water from the roof into the sewer. As they will lead air up as well as carry water down they should not be placed near windows. Under no circumstances should they discharge on the sewer side of the trap or the vent, and there always should be a vent. As a severe storm may overtax the capacity of the sewer, it is a better rule not to run storm-water into it.

General water requires sewerage

Notwithstanding an army in the field is concerned with none of the problems of sewerage as a sanitary art, these do confront the garrisons of our larger modern posts, whose officers should have a general knowledge of them. It is no longer sufficient to assume that when a contract has been made to introduce fixtures all has been done that is officially necessary, or that when the plumbing is complained of nothing can be amiss if no broken pipe or leaking joint is found. It is a fundamental principle that when water is introduced at a post by a pipe system, pains must be taken at the same time for it to be systematically disposed of after use. Otherwise the ground already charged with organic waste will be saturated and under the action of heat disease may arise. This oversight occasionally occurs.

Disposition of excreta

Although the water-carriage of excreta is the exception in the army, particularly at stations remote from the great cities, nevertheless excreta and garbage generally must be promptly disposed of. A garrison cannot evacuate a polluted post, as a command may march away from a defiled camp. So, after a well-ordered sewer system, come in the order of desirability: (1) Closets over deep water, as may be arranged on the sea-coast or great lakes, but not where drinking-water may be affected; (2) Cesspools; (3) Privies; (4) The dry-earth system; (5) Perhaps in the future, the furnace for the disposal of all waste. Cesspools are cisterns, generally walled dry with an earthen floor. Into these is conducted the waste from houses where there may be a water-supply from individual tanks and more rarely from a general system. From them the liquids percolate and the solids are removed mechanically as required. For cesspools to be efficient the soil must be porous, the ground-water low and above all the water-supply beyond possibility of contamination. A large and deep dry-walled privy from which the liquids drain, which is covered when full, is a variety common at some posts. In the deep sand of the south these maintain a long life, but when set in sand or gravel they may pollute the local water. When abandoned they should be, but rarely are, permanently marked to warn future garrisons. The worst privies are the common shallow pits dug for temporary relief, frequently without authority, near stables, corrals, and the married quarters. These are often filled to repletion, insufficiently covered and unmarked, and they honeycomb the older posts. They should be dug only by an authority which specifically designates the place and depth, be systematically closed when no longer to be used, and be accurately marked in place and on the post map. Such care is especially important when the drinking-water is drawn from wells or from a superficial supply. If

Cesspools

Pit privy

a pit is impracticable, as on a rocky site, or injudicious, for fear of subsoil pollution, the only alternative where there is no sewerage is some form of superficial receptacle. This should be either: (1) A water-proof compartment of moderate capacity (not exceeding 10 cubic feet, for convenience of handling), raised a few inches above the level of the ground, with a hinged seat for the introduction of ashes or dry earth as an absorbent, and arranged to be frequently withdrawn and cleansed; or (2) the true dry earth-closet. This requires a small water-proof receptacle into which whenever it is used about a pound and a half of pulverized dry earth is to be thrown over the discharge. Sun-dried earth from the upper soil is full of useful bacteria through whose action the excreta are oxidized and neutralized. In super-heated or stove-dried earth these are killed. Sand and ashes are sterile, and chemical deodorants destroy the nitrifying principle in the earth, therefore these should only be used when the excreta are not infected. No slops should be poured into either form of surface privy. As such privies on a large scale are effective only under a good system of scavengering, which under ordinary military conditions is most difficult to apply, their use is to be attempted only as a last resort. Privies should be screened against flies, and insecticides be occasionally used in them. Where, as sometimes happens, excreta are to be buried in emergency trenches it would be an error to inter them too deeply. The efficient bacteria lie within the two upper feet of the soil, and excrement should therefore be buried only deep enough not to be disturbed by animals or exposed by the rain. There may be an exception in very arid and windy climates where the surface may be blown off. The disinfection of the discharges from the sick and the disposition of hospital refuse are special sanitary measures for which the Medical Department is responsible. Laundry slops contain in solution and suspension excreta from the interior organs and the skin, sometimes charged with disease.

Closet privies

Earth-closet

Emergency trenches

Hospital refuse

Laundry and kitchen slops

Garrison refuse

Kitchen slops are filled with decomposing animal and vegetable débris. The ground where these slops are habitually thrown often becomes indescribably foul from the soakage of such unsuspected dregs. All waste going out of a house not into the sewers should be received in water-tight covered barrels resting on platforms arranged so that the ground beneath may be cleansed and they may be moved to new sites as required. Pending the introduction of an economical odorless furnace, and in the absence of available deep water, the refuse of posts should be carefully separated into the combustible or organic waste, like slops, old clothes, and decaying vegetables, which should be consumed in a fire-pit, and the indestructible as tin cans, pottery, metal and the like, which are to be buried when climatic conditions permit. As soon as provisions are emptied cans should be flattened or cut open so that they may not hold water; and they may properly be passed through the fire to destroy small fragments of food. The "dump" of a frontier station is a monument of sanitary incapacity.

XXVI

MARCHES

Attention

The attitude of the soldier under arms, the mode and rate of marching, his endurance, the character and weight of his load, all affect his military efficiency. It is proper at the outset to warn against a disposition, formerly more insisted upon than at present, and more in other armies than in our own, but which might be reintroduced with us, that when at attention the soldier should stand bolt upright with the head well back and the chest fully dilated. He is taught to keep the chest expanded while in this posture. The constrained position, especially when complicated with the restraint of tight clothing (now happily abandoned) and with the pressure of straps and considerable weight across the front of his chest, limits the natural respiration. This interferes, further, with the normal beat of the heart, which becomes too strong, too abrupt, and too frequent in the effort to overcome the handicap; and as the lungs are not properly exercised, the blood is insufficiently aërated. Marching in this attitude, or in any approach to it, causes severe strain of the heart, and carrying weights across the chest still further taxes the strength. The company officers should correct the zeal of the drill sergeant in developing the statuesque soldier at the expense of his efficiency. The true soldierly position only requires the shoulders to be well squared, the abdomen somewhat retracted, and that, while the body may be moderately inclined to the front, the man shall not fall into a careless position or a slovenly gait. In marching the centre of gravity must remain well within the base formed by the feet, and strength should not be wasted by raising the knee too high or by thrusting the foot forward beyond where it will touch the ground, as in certain foreign display movements, although both are desirable drill exercises to develop the muscles of the thigh and leg. It is desirable, although not easily learned when the body is kept erect, to bring the ball of the foot on the ground first, followed by the heel, so that the shock of the impact may be taken up by the arch of the instep, as in running. It is an error to evert the foot far in walking, because in progression the thrust against the ground is more effective when made by the length than chiefly by the breadth or inner side of the foot, as would follow if turned out too far. But while standing, a wider and therefore a firmer base is secured when the feet are at the prescribed angle of sixty degrees and the body is upright. In carrying weight upon the back the loaded body must bend to the front to maintain its equilibrium, and also when in motion that it may keep the centre of gravity within the shifting base.

Mode of marching

In studying the theory of the march and its practical application, attention should be paid to the flexion step of the French, where all the joints bend and the body inclines to the front. This is said to yield admirable, although not showy, results. To bend forward from the waist is not to stoop and does not contract the chest, although such contraction does follow the common rounded shoulders and bent spine of the untrained. Marching with the inclined body and flexed joints, with the feet raised no higher than to avoid the obstacles of the way, encourages speed with the least muscular effort, for gravitation assists the forward movement. The man must move forward to avoid falling. It is alleged that after six months' training fully equipped French soldiers have covered twelve miles in an hour and forty minutes, that is have marched at the rate of seven miles an hour.* Of course there is a distance limit, but this speed-capacity gives an army possessing it an enormous advantage. Certain Italian corps also are trained to march

Flexion step

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* Firth, *Military Hygiene*, p. 255.

rapidly, much in the same way. As this is but a question of training, not of natural endowment, it is open to other armies to attain similar results by the same methods.

Steps

British and German steps

Japanese step

The direct step of our infantry is 30 inches, and this at 90 steps a minute for common and 120 for marching or quick time gives 75 and 100 yards a minute, or without halts 2½ and 3⅖ miles an hour. In practice this is reduced to a little more than 2 and about 3 miles respectively. Double time requires 180 steps of 36 inches, or one yard, each a minute; which is equivalent to a little less than 6 miles an hour. This is really a run, not a marching step, and is too exhausting for more than rushes and street fighting. It is simply a gymnastic exercise which should commence with very short periods, and after prolonged practice should never exceed a maximum of 20 minutes for picked troops, excepting as they may be brought up to it by training in the flexion step. In such exercises, especially in the practice marches, men should be encouraged to fall out at will; for until well trained a heart is easily strained permanently by such work. The British quick step is 30 inches, 120 to the minute or 100 yards, and the double is 33 inches at 175 to the minute, the equivalent of 160 yards. In "stepping out" the ordinary pace is extended to 33 inches. The quick step of the German infantry is 31½ inches (.8 metre) at 114 paces to the minute or 100 yards, and sometimes a slightly quicker rate of 120 paces of the same length, or 105 yards, is used. The Germans also use a "double" step, 39 inches (1 metre) at 165 to 170 to the minute, about 180 yards. That length of step is too extreme for other than a brief charge. The Japanese step in quick time is about 29½ inches (.75 metre) at 114 to the minute; in double time it is 32½ inches (.85 metre) at 170 to the minute. This appears to be the German rate with the step reduced for physiological reasons. A walking step in excess of 30 inches is too long for the average-sized man to persist in.

Physiology of marching

The physiological relation between the length of the step and that of the lower limbs has some bearing upon the ease of marching. There is a natural pendulum-like swing of the leg which fixes the stride, and although this may be modified within narrow lines it is clear that every person has, somewhere, a limit he cannot pass. As this varies with the individual, the step that a tall soldier can compass may be absolutely impracticable for one who is short.

Leaders of marches

Whatever may be the requirements of the roster, it is unwise to place very tall troops at the head of a column, because they are liable to march away from the remainder or, more exactly, to impose special strain on the others to maintain their places. For it is only exceptionally well-drilled men who preserve exact cadence in route marching. On the other hand, although for the time a tall man may march with greater facility than one who is short, it is the medium-sized men who best make the long marches. Their chest-capacity, which is the basis of vigor, is not sacrificed to disproportionate length of limb. Where it is important that a column should reach an immediate objective in time, it is good policy to place at its head a brigade, regardless of stature, that is known to march vigorously. An example was that of Harris's brigade, trained by long and active marching in West Virginia, which led Turner's division and the Army of the James in its race to Appomattox. Under such conditions, where all are enthusiastic, pride impels the main body to preserve its position. On special occasions any troops, especially any volunteer troops, are influenced by emotion, regardless of their drill, in their efforts to keep up their pace or to loiter, as high spirits or dejection predominate.

Breeches and drawers

Tight breeches are among the restraints in marching, and men should not be permitted, by having their clothing altered, to sacrifice efficiency to appearance. A careful company officer also sees that the drawers, which war contracts are specially liable to skimp, measure full across the hips. It was found during the Civil War that the western regiments required a greater proportion of large sizes in both underclothing and shoes than those from the east. It is probable that the more men have been accustomed to outdoor labor, the more roomy should be their dress, a point of special importance in the field. The hinderance of clothing is particularly marked when scantily clad native levies are put in uniform; and the extreme fulness of the zouave costume, designed for an entirely different purpose, facilitates marching. Another factor in ease of marching is an unencumbered chest. Easy walking requires the freest distribution of blood and co-ordinate freedom in breathing. Pressure or straps upon the chest make the heart's action labored, lessen inspiration, and consequently impede physical vigor. It follows that the conditions may completely alter the relation of the same march to different men; hence it is much better, while insisting upon uniformity for parade purposes, when at route step to allow men to walk literally at will. The less their physical effort, the fresher they will be at the end.

Unrestraint of the chest

Freedom of route step

Marching does not mean merely the regulated movements of the drill ground or progress along an unobstructed highway. It implies a sustained power to pass over long distances with reserve strength to be effective at the destination. The art of marching culminates in that ability of the troops to place themselves where they are required, which vitalizes tactics and strategy and thus in some respects out-ranks fire action. No effort is wasted which enables the mass of the army, not merely a few selected detachments, to take up its true position at the proper time. To attain that ability the ordinary practice march should be an habitual exercise; for it is as much the result of training and experience as marksmanship is, and it is far more important. Because one man moving at his own discretion and unencumbered may cover twenty-five

Marching

Practice marches

or thirty miles a day, it by no means follows that he can do the same when loaded with his necessary equipment and hampered by thousands of others, unless he and they have been taught. Even with well-practised troops, the first stage in a long march, exigencies permitting, should be short.

Route marching

This is as true for cavalry as for infantry. With troops unseasoned in marching, whether old soldiers or recruits, the first stage should be very short. This may gradually increase until the maximum is reached in a fortnight, rarely sooner; although men really drilled in route marching can attain the limit much earlier. In moving out from garrison or from a prolonged camp the first march, whether the troops are seasoned or not, should be for a very few miles, for the command to "find itself." Invariably large expeditions will lack something or will carry an excess, at the very first. The exception of course is a military emergency which brooks no delay. When in the field one entire day out of ten, besides Sundays, should be used for rest and repairs; although stated halts are seldom possible in active campaign. Good infantry will fairly out-march cavalry in a protracted expedition, but, if it can be avoided, those two arms should not march together; that is, they should use independent roads. The act of marching is influenced by the weather, the roads, the spirits of the men, the immediate object in view, and the size of the command. Head winds and extreme heat retard progress, as do deep mud, sand, ice and snow, and all these must be allowed for.

Obstacles

Heavy dust irritates and annoys infantry, but does not impede progress like sand. On fair roads 14 miles in 10 hours is good marching for a large army, but a regiment easily covers the same distance in 4 hours. Seasoned troops sometimes make forced marches of prodigious length at high speed, but single divisions are usually the maximum commands for such successful effort. In every case none but men of assured fitness should be allowed to participate or there will be a trail of the disabled by the way.

Forced marches

Night march

Trains

Open order

Night marching requires at least half as much additional time as to march over the same route by day, besides draining energy through loss of sleep and the extra strain of mind and body required in such duty. Where possible the troops should move in columns parallel to but not on that highway which has been reserved for the trains; for the great comfort of having the wagons well up when camp is made is full recompense for the somewhat greater fatigue of the route. This rule does not apply to relatively small commands. Infantry should march with as wide a front and in as open order as possible to avoid crowd poisoning; for this may occur in stagnant air out of doors as well as within confined quarters. Heat prostration is much more likely to occur in crowded ranks than with skirmishers.

Halts

Sanitary character of marches

Frequent and regular halts are desirable, the first of 15 minutes at the end of 2 miles, when the men should be encouraged to relieve themselves and to readjust their loads, and afterward for 10 minutes every hour or hour and a half. If the halt is designed to be longer or shorter than is customary, it should be announced; and the probable duration of unpremeditated halts should be signalled back from the head of the column, or a mounted officer be sent forward for information. Many interruptions of progress are due to pure congestion of the way, partly by dilatory movement across minor obstacles and partly by the interference of trains and other troops. The first shows poor company discipline, the last bad staff management. The successful conduct of a march is a good indication of military capacity, and the larger the command the more difficult the task. The relation of the conduct of marches to sanitation lies in its bearing upon the physique and the disposition of the men. To hold them in ranks through a halt whose length is uncertain wastes energy, and few conditions fret good troops more than such formalism during uncertain stops. It is no waste of time for men at every halt to spread out and rest; but they should not be allowed to straggle from the column, and they must be drilled into promptly resuming their places. Otherwise the trifling delay each company or regiment makes in taking up the march is magnified as it passes to the rear.

Fatigue of standing

The fatigue of a march is not entirely due to the act of walking. It is nearly as exhausting and much more irksome to stand than to walk, and when a man bearing weights stands in a state of expectant attention there is constant expenditure of muscular and nervous force. Jerky progression is little better, and is very trying to the muscles and the temper of the men at the rear of the column who have no means of knowing the conditions in front. This generally depends upon the leading fours attempting to avoid some little obstacle of mud or water, which should never be tolerated except in very small commands. No particular command should resume the march until its rear is well closed up, otherwise there is constant strain to catch up and a corresponding interference with the interval separating the succeeding regiment or brigade. To minimize such delays, where packs are unslung there should be a preparatory signal for their readjustment two minutes before the advance. When halted, men should be encouraged to lie down flat on the face or the back, having protection from the wet soil. To lie at full length with all the muscles relaxed is a much greater relief than to lean against a tree or to recline in a fence corner. Recruits should be so instructed; old soldiers have learned it by experience. The French are said to save time and avoid the mud by squads of 20 or 30 forming a circle at the brief roadside halts and every man sitting upon the knee of the man behind him. To sound the assembly prematurely is a most aggravating trial to the men in the ranks and a waste of their strength. As Lord Wolseley remarks, "fussy and fidgety commanding officers . . . are prone to turn their commands

To rest halting

out earlier than necessary." The order of march being known, neither brigades nor regiments should be obliged to fall in prematurely. It requires a long time for a division to stretch out, and the rear regiments may well be spared much of this unnecessary waiting under arms. The same principle applies to the annoying waste of time and patience in garrison while awaiting orders for parade and inspection.

Premature "assembly"

In marching, music is more than a gratification, it is an aid. The tap of the drum assists a common step, the fife and drum are exhilarant, and a full band is stimulating. Bag-pipes, unknown to our army, are most animating and might well be introduced. Our soldiers are too silent. Vocal music, especially singing in concert, should always be encouraged, for on the march it is beneficial as well as attractive. It expands the chest and diverts the attention. Columns in route, unlike scouts and pickets, have little to excite them, and they should not dwell on their hardships, but profit by the amusement and the incidental interest their own and their comrades' music supplies.

Music

In campaign men should be required to keep the hair short, to use the tooth-brush, and to bathe daily the head, the feet, the armpits, groins, anus, and genitals. For this purpose a very little water is sufficient. While general cleanliness is always important, that of the groins and feet is necessary for efficient marching, and cleanliness of the perinæum reduces the liability to boils in that situation. Even in temperate climates, new men are apt to chafe in the groins and the buttocks, and if pressed too hard at first they will quite break down with disabilities that otherwise would be temporary. In the tropics the resulting abrasions afford an inviting sphere for distressing parasitic diseases, notably "dhobie itch," which positively disqualify. Unseasoned men with ill-fitting shoes or rough stockings may become disabled from sore or blistered feet. Where the skin

Cleanliness

is not abraded, this tenderness is simply the bruising of unaccustomed muscles, whose only preventive is practice marching singly, in squads, or with the whole command.

Disabled feet

Soreness or chafing comes from misfitting shoes, and is usually the man's fault. In the German army sore feet are reckoned a military offence on the man's part and his captain's. When camp is reached all such men should be sent to sick call, for relief but not to be readily excused. Painful as blistered feet are, permission to ride should be given sparingly for its effect on others. A man who "walks on the nail" has been inadvertently enlisted and should be at once taken out of the ranks and discharged. The army, with any approach to equality with its adversary, that marches best will win the campaign.

Night marching

As a rule camp should not be broken before daylight, and night marches are to be avoided. The broken rest overbalances any ordinary advantage from prolonged repose due to an earlier halt, for soldiers on active campaign are not apt to sleep before night. Marching at night is difficult except over well-defined and open roads, and from a military point of view such expeditions of any length are notoriously liable to fail. From sanitary considerations they are objectionable; in winter as more exposed to the cold, in the summer as especially inviting nocturnal insects, including the fever-bearers, and at all seasons as destroying rest. Elsewhere than on a broad smooth road under full moonlight, nearly double the ordinary time should be allowed for night expeditions. This does not militate against assaults at the break of dawn where the immediate end overrides sanitary considerations; nor the equal necessity, in the immediate presence of the enemy, of being under arms at that hour to repel such assaults. But when possible hot coffee and hard bread should be served before falling in. It is obvious that there are many occasions when night marches *must* be made, but this advice is against their employment merely because of presumed convenience. In the tropics there is temptation to march at night to avoid the sun's heat, but experience opposes it. Tropical marches should invariably begin early and be suspended during the five hottest hours, when if necessary they may be resumed later. Now that it is known that it is not miasmata but mosquitoes that are harmful, reasonable precautions may be taken during the border hours when they are afield. But the mid-day sun is as deadly as malaria, although through another channel, if challenged without protection. An officer, ignorant or ordered by authority that spurned official advice, has paraded men in a tropical mid-day for a march that as well might be made earlier or later. There is reason to fear that this is not exceptional. When there is any choice of hour for a tropical march, it should be so arranged that whatever inclination there may be in the nearly vertical sun, the men's spines are to be given advantage of it as far as possible. Special spine protectors in our service and orange light interceptors are yet on trial, but the presumption is in their favor. Continuous tropical heat directly on the spine is nearly as harmful as when pouring on the head.

Tropical marches

Some experienced men in marching use merely a damp cloth on the face and neck at rising and fairly wash only the eyes and mouth. There is less irritation by the dust of the way when the natural oil of the skin is not unduly removed, and there is less liability to sunburn. On making camp the more completely the person is bathed the better, but a surprisingly small quantity of water is necessary for cleansing the person if used judiciously. One quart of water with a sponge or a cloth is sufficient. In temperate climates as a rule no fluid should be drunk, except with food, until the end of the march is near. If a man begins to drink while marching, the desire increases almost irresistibly. The rare exception is for the relief of positive exhaustion from excessive perspiration. But canteens of water or weak tea should be carried as a precaution. In the tropics, to avoid heat prostration when the blood loses

Washing the face

Water on the march

too much of its fluid through perspiration, that waste must be supplied by the judicious use of water. This privilege is liable to abuse, and intelligent non-commissioned officers should be on the alert to control it. The canteens should never be replenished from the roadside — this is imperative — but only from a regimental supply of boiled or otherwise certified water carried with the command. As the sensation of thirst resides in the fauces and often is present when there is no physiological thirst, it may be relieved in great part by carrying in the mouth a pebble, or other small solid, whose presence maintains moisture there by inducing a flow of saliva. Abstinence from fluid while marching is an easily acquired habit of great convenience, for the man who begins taking water on the route will find himself in a state of chronic thirst from no real deficiency, but because the dryness of the mouth is relieved only for the instant.

Straggling

Although marching troops are conspicuously healthy troops, it is impossible to win battles unless the men are present for duty; so a medium of speed and distance, which both health and discipline mark as a standard, must be attained and maintained. Straggling is a serious evil that directly affects physical vigor as well as military power. And it is an evil which grows powerfully through example. The moment that men elude control and drop out of ranks they lose the advantage of the care that organization confers and the powerful moral support of a common purpose. As companies and regiments disintegrate, the individuals, deprived of the help and encouragement of the military society to which they belong and depressed by the dejection of other stragglers, pursue a weary way without vigor of body or unity of purpose; and in proportion as they multiply the army ingloriously dissolves. Therefore an adequate ambulance train should constantly be at hand to transport the really ill, for good troops always repay thoughtful care by putting forth their best efforts in the faith of protection when disabled. But to select the ill from the lazy,

Ambulances

the unfit from the unwilling, those claiming to be sick should be promptly and rigidly scrutinized, with the presumption against them, by a medical officer of judgment after their company commander has authorized them to fall out. Illness rarely occurs so suddenly that, it may be at some inconvenience, a man cannot keep up until the next halt, and company officers should assume part of the responsibility of retaining men in ranks long enough for medical inspection. On the other hand want of consideration and too persistent forced marches may keep thousands off the firing line in spite of relentless discipline. A probable illustration of this is the case of the German Garde-Corps, presumably selected troops, in 1870. They left the Rhine, 30,000 infantry, August 3d; they lost less than 9,000 in action; the morning after Sedan, September 2d, they numbered 13,000; and they reached Paris, September 19th, with 9,000 present. That is, in about seven weeks more than 11,000 were broken down by over-exertion, for the camps were so brief and the operations so active that there was little illness. Nevertheless it is the rule that marching troops are healthy troops, and the less any soldiers remain in garrison or camp the better for them.

Over-marching

It is manifest that the soldier in the field must bear upon his person certain essentials. At a minimum these are arms, ammunition, and a moderate supply of water and food. What else should be carried has long been seriously discussed and is not to be settled off-hand. Raw troops invariably overload themselves and afterward recklessly abandon property that they should retain. After careful inspection, to be frequently repeated, every ounce not formally authorized should be relentlessly discarded and a strict responsibility enforced so that nothing else is thrown away. It may be well on taking the field to prepare two schedules, one of articles that must, and the other of such as may, be carried. The limit of the first should not be lowered nor that of the second be

Carriage of weights

Double schedules

exceeded; but in fact there need be little difference between them, for to carry unnecessary weight wastes energy. There is a strong modern feeling that the infantry should have everything, the implements of war and daily food excepted, carried for them, so that the very name "pack" seems almost to be regarded as a degradation and hardship. That is a fundamental error. The soldier must be self-sustaining wherever he may find himself, independently of the trains. This has always been an essential of his occupation and is no impossibility. The practical difficulty seems to be not that men of true military age are less sturdy than they were, but that so much material now looked upon as necessary was formerly thought superfluous. As the required weight varies with the climate and the duty, and as particular articles are replaced by others or the standard patterns are changed from time to time, it would waste attention to study in detail the shifting figures. But in a general way it is necessary for the soldier to possess his arms, ammunition and accoutrements, about 23 lbs.; one day's food and water, 3½ lbs.; carrying equipment exclusive of knapsack, about 4½ lbs.; blanket and shelter-half, 8 lbs. (dry); and clothing upon the person, 10 lbs.; or a total of very nearly 50 lbs. This is easily increased by more rations, extra ammunition, a change of underclothing, and additional equipage, as slicker and tools. Notwithstanding it is the object of all services to reduce this to the minimum, the British infantry carry about 50 lbs. and the continental infantry between 60 and 75 lbs. per man. It is, however, the distribution and the method of carrying, rather than the gross weight, which is oppressive. Thus the clothing as worn weighs from 10 to 12 lbs., and more in severe weather. When badly fitting it restrains movement, but it is so distributed upon the person that its weight as such is not heeded. The rifle may be shifted within certain limits. The canteen and haversack and their contents, utensils, ammunition, tentage, and spare clothing are the dead weight, but this is trifling

Pack

Necessary weights

compared with what other soldiers and many civilians carry without complaint or serious inconvenience. The real distress comes from the pressure across the chest and under the armpits, which interferes with respiration and circulation, and from the want of ventilation at the back. In proportion as the chest is unimpeded will the vigor of the man remain unimpaired until he is literally borne down by overweight. It is a fundamental fact, too often overlooked, that the lungs must freely dilate for the admission of the air which exertion demands, and the elastic walls of the chest must expand for their accommodation. When such natural expansion is restrained, the action of the lungs is proportionately trammelled and there follows automatically the heart's effort to compensate for the insufficiency of air by trying to drive the blood more rapidly through the lungs for aëration by what air is present. But even the heart's own action is partly fettered by the restraint of straps that bind down the chest. This requirement of free expansion is apt to be overlooked, and the fact to be neglected that in exercise those vital organs require physical freedom, not merely for the man's comfort but for him to do efficient work. This primary principle is bound up with that ability. The old knapsack held the chest as in a vise and increased the soldier's fatigue by cutting off his air. Besides, straps under the armpits were painful and sometimes caused temporary pressure-paralysis of the arms. In the effort to escape from that confinement, the inadequate makeshift of a blanket-roll was evolved in the field. The first formal substitute was the clothing-bag to be worn upon the hip from a brace yoke, issued about 1874. This was replaced in 1882 by the blanket bag, which in substance was the old knapsack leaving the chest somewhat freer. It was so unsatisfactory that the unofficial blanket-roll has been permitted in orders to be worn "until some more satisfactory method of carrying the pack has been devised." The blanket-roll, evolved by the exigencies of the

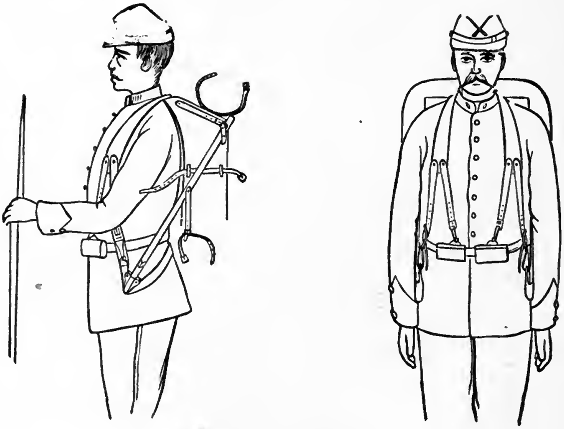
Pressure upon the chest

Knapsack and substitutes

Blanket-roll

Yoke

field and used by both armies in the latter part of the Civil War, is simply the soldier's blanket, in which spare underclothing and small articles are enclosed, rolled lengthwise with the ends tied together. This is carried across the body from one shoulder. The shelter-half is usually wrapped around the blanket. The roll is inconvenient in affording no protection for the contents when the blanket is in use, and it is oppressive in that it heats both breast and back, and lying against the chest its weight seriously impedes respiration. To relieve the chest a yoke of bent wood to which the roll was lashed and held from the body has been tried, but although excellent in theory it was found that the weight when not partly borne against the body pressed too heavily upon the collar bone.



Merriam Equipment.

Merriam equipment

The conditions of military necessity and sanitary requirement seem to be nearly, if not entirely, met by the Merriam equipment. Although through a term of years permitted for regimental use, where it appears to have been acceptable, this has not made its way into official favor or into general recognition. Its physiological advantages are: The weight is taken up by the pelvis; the wallet or receptacle falls slightly away from the back, so that there is ventilation; the entire chest is free from pressure; it may be slung and unslung without delay; and if desired it may be worn with the coat perfectly open. This equipment has two compartments, one for spare clothing, in which extra ammunition also may be packed in an emergency, and one for rations. This dispenses with the haversack as a separate article. By shortening the strap the canteen may conveniently be attached to the equipment, instead of the strap passing across the breast. It is an undecided question how far it is desirable constantly to carry a receptacle for two kinds of supplies when it may contain only one. This is not the rule, but it is an important exception to the rule. For sometimes all that the soldier actually requires with him besides his arms and ammunition, are rations and water. Emergency ammunition usually can be stowed in pouches and pockets. Spare clothing should always be in its case, however the soldier may be separated from it or wherever he may be engaged; and the equipment itself would be an impediment in action, particularly if loaded with articles not needed at the time. For the carriage of rations as an alternative to the full equipment, an acceptable substitute would be a water-proof sack, expansible or not as may be determined, to be detached from a permanent strap when not in use, and worn only when the equipment is not carried. Then when in light marching order or on going into action, the full equipment may be left behind and only the rations and water for the day be borne upon the person. It is open to inquiry whether this equipment affords sufficient space for spare clothing along with the rations, and it is not arranged to carry both an overcoat and a blanket. These considerations are minor and secondary. The essential principle of the Merriam equipment appears to solve the carriage of the soldier's effects in the field. That the entire chest is free from any pressure is the preëminent advantage. Personal tests by men who cannot wear the blanket bag give them perfect freedom of respiration and motion, and pedestrian tourists accord it special praise. The required straps and rods appear complicated and objectionable to the inexperienced; but they are designed for individual adjustment and are not complicated, and when this adjustment is once effected the equipment may be used indefinitely. The garrison soldier detests the very name of "pack," and the enlisted man with only the day's march before him naturally prefers to bear no weight. But accepting an equipment as a necessity, this is the most rational and the least objectionable of all the appliances. Unwisely small commands marching to change stations have sometimes had their knapsacks, or the equivalent, carried in wagons, so that certain officers and men look upon this as a legitimate custom of the service. But an army in campaign can depend on no such precarious help.

Shelter-roll

Bandolier

Heavy marching order

Originally the shelter-half was carried on top of the knapsack. Now there is authority to wear it conveniently prepared as a roll across the body, but that is trying to the wearer. The supply of the modern small arms introduces a new problem in the carriage of burdens. More ammunition than ever must be at hand, and the temptation to use bandoliers revives the older evil of chest compression. The bandolier, convenient as it seems, should be discouraged as a form of permanent infantry marching equipment; for distribution, not weight, is the vital point. With multiple pouches and pockets for the regular allowance, an individual reserve in the bandolier may well be carried on pack animals instead of on the person. For such animals must also bear the general reserve small arms ammunition for issue when contact is imminent and a part of the ordinary equipment is temporarily laid aside. But for the marching soldier to be fit for field work and action, he must day by day be independent of pack animals and wagon transportation and be accustomed to bear on his back suitable field equipment. To defer such familiarity with necessity until the campaign opens is to invite defeat.

XXVII

WATER

Derivation of drinking-water

Surface and ground waters

Deep supply

Water is more necessary to animal life than is food, and it is also essential to vegetable growth. Its apparent origin is the clouds, which are replenished by evaporation from the ocean and other reservoirs, whereby a circle of supply is completed. But the immediate source of the most of the drinking-water is streams (including ponds and lakes), springs, or wells, and these are filled, generally indirectly, by the rainfall. Surface water is the rain or melting snow, which in part runs off to swell the streams, and the streams themselves; and the subsoil- or ground-water is that which has soaked into the ground and is supported by the first impenetrable stratum, as previously explained. The subsoil-water follows the inclination of the underlying strata, which usually is toward the valley of the nearest water-course, so that much of the volume of a river is made up of this water which enters it below the surface as the effect of this lateral flow. The subsoil-water also has a perpendicular movement, depending chiefly upon its quantity and the obstacles to its transverse course. That the water does not escape from a river through its banks, although increasing its volume in that way, is due to the silt with which the banks are lined that makes a coating impervious to outward flow. Besides the subsoil-water, a deep supply is to be found almost everywhere at much lower levels. This deep water is derived from the rain water that has followed the lines of upturned strata which pierce impervious layers until it is held at a great depth, either in limited natural reservoirs or in immense beds whose source of supply may be far distant. Water that escapes from the surface of the ground in moderate quantities is called a spring. A spring may have a strictly local origin and temporary life, as the outcome of rainfall upon higher neighboring ground, in which case in a populous region it is quite as liable to be impure as pure; or it may flow permanently and freely, the manifestation of a deep-seated and perennial supply from a remote source. A well is a shaft sunk into one of the water-bearing levels, generally yielding by extraction a more liberal supply than an ordinary spring. Cisterns are artificial reservoirs, usually of small size and designed for rain-water. A tank is the common name of a local reservoir for water pumped from wells, or for the more convenient distribution to a small community, as a garrisoned post, of water diverted from a distant general supply. For these there are certain general rules. Thus: Wooden receptacles, whether above or below ground, are prone to decay because of the fluctuating water-line. Underground cisterns may be leaked into through the wall or from the surface. Uncovered tanks, whether above or below ground, not only collect dust and leaves, even at a high elevation, but birds, insects, and sometimes the smaller climbing animals drown in them. All these require frequent inspection and stated cleaning. All cisterns should be ventilated and also are to be carefully guarded against mosquitoes, for when accessible, especially if not in constant use, they become ideal breeding-grounds for those noxious insects. Overflow cistern pipes ought not to connect with sewers, lest foul air from the latter should be absorbed by the water to which the pipes would conduct it. Iron tanks are liable to wear away, to choke the pipes with rust and to discolor the water. Lead-lined tanks, sometimes suggested, are dangerous because soft water readily takes up lead, which is poisonous. Galvanized iron may be used only if it is of the best quality; otherwise the zinc may be given off, especially in water charged with nitrates.

Springs and wells

Cisterns and tanks

Mosquito guards

Overflow pipes

Materials for tanks

The taste of zinc is disagreeable, and the metal is poisonous when continuously absorbed. In hot climates galvanized tanks must be protected from the sun by a casing of wood, and in cold climates all overhead tanks should be encased and be guarded by artificial heat against frost. On all these accounts, where gravity is not required as a distributing force, underground cisterns of brick well lined with cement, and, where gravity is needed, above-ground tanks of wood, notwithstanding their shorter life, are the better. In brick cisterns common mortar should not be used, because the contained lime may make the water hard.

Rain-water

Rain-water collected from a clean surface after the atmosphere has been well washed is the purest in nature, but uncontaminated storage is so difficult as to degrade cistern-water from the first rank. In the collection of rain-water the dust should be washed out of the air before the rainfall is secured, and unless the collecting surface also is very clean the first rainfall should be allowed to run off, or to be carefully filtered, for all such washings introduce a rapidly decomposing sediment. The bacteria of nitrification, which are purifying agents, may be introduced into wooden cisterns by throwing in a little clean gravel, on which they are always found. The quantity of water that may be collected from a non-absorbent surface is determined by multiplying the area in inches of the horizontal plane by the depth of the rainfall also in inches. That is, square feet reduced to inches (×144), multiplied by the inches of rainfall as determined by a gauge, will give the total cubic inches of rain. This divided by 1728 will give the cubic feet, or by 231 will give the United States gallons of water.* The area of roofs is that of the horizontal plane they cover, not that of the slopes. Excepting rain-water from a perfectly clean surface in a protected reservoir, the best water-supply is from springs, remote from human habitations, large lakes, and streams flowing through unin-

To measure the rainfall

Relative purity

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* The English gallon is 277.274 inches.

habited regions. The denser the population and the more its waste is discharged upon the ground or directly into streams, the worse the situation. Wells may obtain their water from

Wells

either the ground-water or the deep supply, and without a fair knowledge of the local geology it is impossible to determine from which it comes. The arbitrary rule, to which there are many exceptions, is: Wells less than 50 feet deep are shallow and gather their water from the general subsoil supply; those more than 50 feet deep draw from the deep water-bearing levels. Nor does the depth of a well determine off-hand the source of the water. For example: Both London and Paris lie over impervious basins into which water drains from great distances and where it may be reached by the artesian method. That is, the water rises in the well by the pressure from the levels higher than that where it is tapped. But New York is underlaid by rocks that are nearly perpendicular to the horizon, so that its subjacent water is practically surface water which has soaked along the lines of the upturned strata. In unstratified rocks there is no such soakage. Should the surface soil not be polluted, the water in shallow wells is as good as that in deep wells. But where the soil is contaminated it is only a question of time when the well, whatever its depth, whose water passes through it will become equally foul with a shallow one; so that the longer and more densely the neighborhood has been inhabited, the greater the risk. Ordinarily well water in a closely inhabited region is of doubtful excellence, and dwellings that stand 100 feet, or less, apart should condemn intervening wells. The rule is

Drainage area

general that wells drain into themselves inverted cones whose radius equals their depth. In sand the area of soakage is much greater, and any well may receive a supply of pure or impure water through a fault or fissure in its shaft or gallery. Bearing in mind the lateral flow of all subsoil water, wells should be placed so as to collect the ground-water moving toward, not escaping from, a polluted site; and no well, even in search of deep water, should pierce a polluted basin because of the risk that water from the upper levels may be conducted to the lower level along the shaft. The driven well is a comparatively modern device adapted to military use on campaign and also at selected cantonments or posts. It consists of an iron tube in sections, which are screwed together as required. At the lower extremity is a steel point, and the first section is perforated for two or three feet from the end. This is forced into the soil, and additional sections are attached as needed. When the level of the subsoil water is reached, a pump is applied, and after the muddy water is drawn off the flow runs clear. There are few places, even deserts, which, not being too rocky or filled with lava, will not promptly afford water through properly operated driven wells. Water in considerable volume may be obtained for permanent posts by gangs of such wells set in a fluvial valley. Driven tubes should preserve the water from contamination from above if they are properly protected where they escape at the surface. When desired, water may usually be found easily in the dry bed of a "sunken" stream, or good water may be obtained by piercing the bed of a polluted river and pumping through a water-tight casing from the parallel sub-fluvial flow. An island in the river usually affords an excellent base for such an operation. On a larger scale, although this is a matter of sanitary engineering rather than of military hygiene proper, water may be collected by subterranean galleries established across the flow of the subsoil water and deep within its zone, permeable on the side through which the water enters and on the bottom, and impermeable where it would escape. But the error must not be made of placing it as though it would collect water *from* a river. Water found near the sea is usually brackish, but sometimes a large underground volume of fresh water flowing from higher ground holds back the salt water that percolates through the sand so that wells very near the shore may be fresh. Occasionally a spring of fresh water may be found below high-water mark,

Driven well

Underground galleries

Wells near the sea-side

covered without being destroyed at high tide, an excellent illustration of the movement of inland water toward the lower levels of natural basins. When brackish water is found near the sea, wells sunk in succession further and further inland finally escape the saline influence. In searching for water Parkes advises that depressions in the surface of a plain be tested, and that even on a sandy plain moving mists or swarms of insects indicate water not far below, and that in grassy plains water is most likely to be found where the herbage is densest. While that is a valuable sign for finding water, it must be remembered that if water is easily reached because the ground-water is comparatively high, that would further indicate an insanitary site for a post or a camp of any duration. Parkes also advises that among hills wells, that is trial pits, should be sunk at the lowest point, not on a spur; at the junction of valleys; and always on that side of a valley which is next to the higher ground.

To find water

Water, which is so essential to life, is liable to many variations from the normal, the most of which are unobservable by the senses and some of which are vital in their character. It is a grave fallacy of the unlearned to believe that, excepting where it is grossly contaminated mechanically, the appearance or the taste of water is evidence of its essential purity, or that it is wholesome because sparkling and without unpleasant flavor. Outside of the laboratory there is no perfectly pure water, for by its very great solvent power water takes up portions of innumerable substances that come into contact with it, and it also holds in suspension many foreign bodies accidentally introduced. Substances in solution completely disappear and cannot be filtered out, as for instance salt or sugar. Suspended substances do not entirely disappear and their presence may be shown by turbidity or opacity. Discoloration, however, in itself by no means certainly indicates suspended contents, for some pure solutions, as that of copper sulphate or the stain of some vegetable

Contamination in water

Solution and suspension

Foreign matters in water

Bacilli in water

Substances in solution

growths, are far from colorless and yet the coloring matter may not be filtered out. Water may contain mineral matter in solution, as the natural alkalies of soda and potash and the salts of iron; organic matter in solution, as the natural extracts in swamps of cedar or peat and the artificial infusion of tea; mineral matter in suspension, as mud and sand; and organic matter in suspension as sawdust and sewage. These foreign substances may be harmless, as the ingredients of medicinal springs; or they may be indirectly harmful or have disease-causes associated with them, as in the output of body-waste. The most serious harm in contaminated water depends upon the presence of the tasteless and invisible bacilli which may throng water-courses and wells and, being imbibed, cause such specific diseases as dysentery, typhoid fever, and cholera. Water charged with organic waste is liable to be infected at any time. Dissolved matters can be removed only by chemical action or by reducing the proportion of water through evaporation (distillation), so that a part of the contained solid is precipitated. The akaline waters of our western plains contain great quantities of soda, potash, and magnesia, and are conspicuous examples on a large scale of watery solutions. As far as known they may be purified only by distillation. They are more disagreeable in the wet season because the alkali with which the soil is permeated, left on the surface by evaporation in the dry weather, is washed into the wells by the rains and passes into them with the increased soakage of the ground-water.

Hard water

Water is arbitrarily classed as hard or soft as it contains more or less than ten grains of mineral matter to the gallon. It may be anticipated that the water "which flows through calcareous channels is hard and that which flows through silicious rocks is soft," the hardness depending upon the lime, magnesia, iron, baryta, alumina or other minerals that have been taken up. It is very difficult

Change of water

to cook certain vegetables, especially of the type of beans, in hard water, and a great deal of extra soap is required to neutralize the hardness for effective washing. It is therefore of economical importance to quarter troops when practicable in a soft-water region. In practice hardness is recognized by the curdling that follows an attempt to dissolve soap in the water. Soaps are alkaline oleates which quickly form a lather when mixed with pure water, but in the presence of the substances that give hardness oleates are formed and no lather occurs until the bases are thrown down. Resting upon this is the soap test, one of the convenient methods of determining hardness. There a standard solution of soap is used to neutralize the bases, and the degrees are established according to a fixed scale. Hard water is generally bright and sparkling in appearance, and persons accustomed to drinking soft water usually have some intestinal trouble after drinking hard water. The reverse is also true, in that the drinkers of hard water are apt to have similar trouble upon drinking soft water. Other sanitary conditions being equal, mortality is not influenced by the hardness or softness of the water-supply. But where it is known that a required change of station will involve the use of a different character of water, company officers should warn their men, both directly and through their non-commissioned officers, as to the consequence of drinking the new water in excess, and should advise them to be moderate in the amount until the system accommodates itself to the new conditions. This is proper, because the profuse diarrhœa that such a change is liable to institute weakens the man for the time and seems to open a possible way for disorders that otherwise might be escaped.

To remove hardness

What is known as the total hardness of water, which depends upon the bicarbonates of lime and magnesia in solution and upon the presence of free carbon dioxide, is divided into the temporary or removable and the permanent or fixed hardness. Now when water is boiled for half an hour carbon dioxide (CO_2) is expelled by the heat and the

By boiling

By soda

Clark's process

bicarbonates are transformed into simple carbonates, and these being insoluble are precipitated so that from them the water may be poured off or they may be strained out. Certain soluble compounds (usually sulphates) of lime and magnesia remain in the water and cannot be extracted. They represent the permanent hardness after the temporary hardness has been removed. It is very well to boil the cooking- and drinking-water in this way and for this purpose at stations where it is very hard. In a small way the addition of sodium carbonate (washing soda), which is the domestic laundry practice, sets up a reaction which creates sodium bicarbonate and lime carbonate. The bicarbonate is soluble, but the insoluble carbonate is precipitated and thus avoided. The third and the best method is known as Clark's process, and is noted here chiefly to illustrate its principle. In the military service it would be most apt to be used, if at all, for a very large post which had an independent supply of very hard water. In Clark's process the determining agent is lime, and the quantity required is decided by the soap test. The addition of lime subtracts a certain amount of carbon dioxide (CO_2) from the soluble bicarbonate of lime, which is thus converted into an insoluble carbonate and falls to the bottom with such other carbonates as may have been present originally. As an example, should it be found that there are 20–30 parts of bicarbonate of lime in 100,000, then about one gallon of clear lime-water should be added to every ten gallons of water, or 9 ounces of quicklime to every 400 gallons of water. Used on the large scale for which it is especially designed, besides improving the quality of the water for the table a great economic saving is made in the consumption of laundry soap.

Suspended substances

Besides what it takes up in solution, water may hold in suspension both organic and mineral matter, and it is against this suspended material, much of which is offensive to the eye, that the most of the processes of clarification and filtration are directed. Filtration acts upon the invisible as well as the visible elements, and clarification incidentally purifies as well as clears the water. Muddy water usually contains in suspension insoluble particles of slightly greater specific gravity than the water itself, so that when allowed to rest sedimentation will free it from most of the foreign matter and, speaking generally, the remainder may be removed by straining. Therefore settling-basins on a large scale are important adjuncts to reservoirs, especially where the water is derived from streams running through alluvial bottoms. But although unsightly and unpleasant, mud as found diluted in drinking-water rarely causes other disease than the diarrhœa due to its mechanical irritation. This, however, sometimes is grave and persists as long as the cause lasts. Sedimentation on a small scale is often efficacious for domestic use, and water as muddy as the Missouri will become perfectly clear if undisturbed in a covered vessel for twenty-four hours. The suspended alluvium gradually but completely falls to the bottom and the supernatant liquid may be poured off. With care, such as excluding dust by a closely-fitting cap and keeping the vessel undisturbed for at least twenty-four hours, a supply of good drinking-water may be maintained for barrack use. This requires duplicate receptacles, so that as the water is drawn off each may be carefully washed out. Clear water is not to be assumed as necessarily pure water, but clear water at least is not repulsive to the eye. Precipitation implies passive sedimentation as just described, or it follows chemical changes. These cause clarification by depositing the suspended matters. The most convenient agent, especially when the water is moderately hard, is alum. Of this about six grains may be added to the gallon or a lump of alum in a net, or even in the hand, may be moved to and fro through the water. It should be observed that no solution of the alum itself is swallowed. Some persons have an exaggerated fear of the poisonous qualities of even minute quantities of alum, but in this case that agent undergoes chemical

Sedimentation

Precipitation by alum

decomposition so that it is no longer alum, and its components fall to the bottom along with the impurities in the water which they embrace. When the water is very soft, a little calcium carbonate (as lime or lime-water) and sodium carbonate (washing soda), ingredients in most naturally hard waters, should first be introduced. The calcium sulphate and the bulky aluminium hydrate which then form entangle the suspended particles and all the constituents gradually sink together, when clear water may be drawn off.* The classical illustration of this method is the case of the British 92d Highlanders on the turbid Indus in 1868. Half of the regiment drank the untreated river-water and suffered from diarrhœa, while the other half used alum in the water and was exempt. The first half then adopted the alum and the diarrhœa ceased. This treatment of river-water muddy from contained alluvium is simple and effective and nearly always available.

Precipitation by iron

Where water is turbid from clay and finely divided organic matter, an ounce of iron perchloride to 250 gallons will clarify it through precipitation. Should excess of iron cause acidity, that may be neutralized by the gradual addition of two or three ounces of sodium carbonate as required.

Clarification by cactus

It may be remembered for experimental use in the field in a cactus country, that fresh cactus leaves cut up will clarify some turbid waters.

Algæ in water

The disagreeable fishy or oily taste and odor found in certain waters, and due to algæ (minute vegetable growths), may be mitigated or removed by adding one ounce of citric acid to sixteen gallons of water. Citric is the predominating acid in limes, lemons, and similar fruits, is harmless to the system and, properly diluted, is acceptable to the taste.

Clarification by tannin

When water may stand for some hours and there is no iron in it, a small quantity of tannin has a similar but less agreeable effect. Growing vege-

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* Commercial alum is a double sulphate of aluminium and, usually, potassium. The calcium carbonate forms an insoluble sulphate, leaving a voluminous aluminium hydrate.

Vegetation in water

Appearance and quality distinct

tation, notwithstanding it may color the water green, is usually of advantage. But decaying vegetation is harmful. A very few bacteria are colored, and they may be numerous enough to tinge the water; but this is rare, besides which its unusual appearance does not determine that the water is harmful. On the other hand dangerous water may be sparkling to the eye and pleasant to the taste, because charged with the nitrites of animal waste. The senses therefore are not trustworthy witnesses to the character of drinking-water, and the distinction between improving its appearance and insuring its wholesomeness must always be borne in mind. Precipitation, and in fact mere straining, rids the water of mechanical or visible impurities, which are irritating; but the dangerous conditions, the disease-causing agents, usually are the invisible bacteria to be either destroyed or removed as most convenient, and the two remedial agencies shade into each other imperceptibly.

Potassium permanganate

Charred casks

Bromine a germicide

The disagreeable odor of impure water may be removed by adding a teaspoonful at a time of a bright solution of potassium permanganate (Condy's fluid) to 3 or 4 gallons of water until a permanent light color is obtained. Should a cloud of suspended matter appear, about six grains of alum with a little calcium carbonate will carry it down, provided it stands a few hours. The permanganate is an oxidizer and its action is directed against the specific bacteria and the organic matter which sustain them; and its reputation as a preventive of cholera has revived in India after a period of discredit there. Where water must be stored in wooden casks, their interior should be charred occasionally. Within moderate limits this disintegrates organic matter. Schaumberg alleges that all pathogenic bacteria in water are killed in five minutes by 1 cc. of a 20 per cent. solution of bromine and potassic bromide each to 5 litres of ordinary river-water. When the water is very hard or grossly polluted, more of the solution should be added until a yellow tinge lasting half a minute follows. Under any circumstances a 9 per cent. ammonia solution, equal in volume to that of the bromine solution, must be added, or the solution be debrominated by sodium sulphite tablets. Chemically the bromine method appears trustworthy and well adapted for small parties and in theory for large commands, although the English were not satisfied with it in the Sudan expedition of 1898. There is some reason to suppose, however, that the working organization may have been inadequate. A kilogram (2.2 lbs.) of bromine should sterilize 16,000 litres (3500 gals.) of common water. But the bromine, which is difficult to handle, must be contained in glass capsules of convenient size and all the reagents be transported with great care, so that it seems too delicate a scheme for a great army to depend upon. But company officers on minor expeditions might be thus equipped under special instructions, and its use popularized by degrees. Notter and Firth, after practical experience, strongly commend 15-grain tabloids of 70 per cent. sodium bisulphate, sweetened with saccharin, and flavored with oil of lemon, one for each pint of water, or two to a canteen. The taste, which resembles lemonade, is not disagreeable and the drug is perfectly innocuous to man. It is confidently asserted that, exposed to it for twenty minutes, the bacteria of cholera, typhoid fever, and dysentery are certainly killed. The efficient use of these preventives requires their action, not necessarily their composition, to be carefully explained to the troops, who should be supplied with them on all occasions of detached service and be cautioned to drink no water with which the tabloids have not been in efficient contact. In fact it should be constantly impressed upon the men that in the field untreated raw water as a beverage is as dangerous as a display of fireworks might be at a powder magazine. The sodium bisulphate tablets appear particularly adapted for mounted commands. Where circumstances permit, as on transports, at posts, and

Avoidance of untreated water

Distilled water

in some camps, the drinking-water may be sterilized by distillation. But distilled water may not be as faultless as appears at first sight. If the supply is very unclean, as in some foul harbors, certain impurities may be carried over with the steam and affect the bowels. Distilled water constantly used is apt to irritate, sometimes because of its very purity and its solvent power and sometimes because it may carry over metallic solutions of the apparatus. Lead, zinc, and copper, either alone or in combination with other metals, should never be in contact with distilled water, and constructing and supervising quartermasters should constantly inspect against such possible contamination.

Boiling

Flat taste

The every-day and efficient treatment of water, which is nearly always possible even in active campaign, is by boiling. This may be by companies or squads in camp-kettles, or by every man for himself in his tin cup; but until it becomes an automatic habit the non-commissioned officers must be vigilant to prevent water as found in wells and streams being drunk, unless officially announced as safe. Otherwise cruel experience may enforce its lesson. It is a false security to suppose that one boiling insures perpetual safety. Boiled water may be contaminated by fresh exposure in other ways, notwithstanding the original pollution will have been neutralized. In the field, to boil the drinking-water thoroughly shortly before drinking it may avert unnumbered woes. "The field" in this meaning includes the practice marches and manœuvres of peace as well as the operations of war, and without this care troops returning to garrison may bring typhoid fever with them. The prepared camps of instruction, whose water-supply is carefully protected, should be exempt from original water-borne cases, but the wells of villages and farms are fertile sources of this distemper. The flat taste of boiled water is due to the contained gases having been driven out. The air may be partly restored by pouring the water to and fro, or by simply dashing it about and thus entangling the air.

But insipidity is a small price to pay for relative security. Boiled or distilled water does not keep, especially in tropical climates, as well as untreated water.

Filtration

Excepting the simple sedimentation, the treatment just explained is based on some form of chemical action or on heat, which changes the inorganic contents of the water or directly destroys its bacterial life. There is, besides, the mechanical removal of deleterious substances by filtration. This in one form or another is directed against suspended material, dissolved substances, and bacterial organisms contained in the water. Filters act in one of three general ways: (1) By straining, or mechanically arresting suspended matter too gross to pass through their pores; (2) By the attraction of masses, as when minutely divided contained substances adhere to the filtering material while water passes slowly through the interstices; (3) By the removal of dissolved substances through the action of chemicals, which form new compounds and the whole are restrained together. As this third method is applicable only to large volumes of water supplied to considerable communities, it requires no discussion here; for if operated at a large post it should be under the direction of specialists. Sand filters also are too costly in construction and too exacting in care for military posts, but they are so efficient in removing bacterial and other organic causes of disease that their principle should be understood. Built for generous service, a sand filter consists of a broad and deep bed of fine sand imposed upon coarse sand, which rests on fine gravel and that, in turn, on coarse gravel. Such a filter would restrain impurities mechanically, but its most valuable function is the nitrification of organic matters and the destruction of microscopic life. This is effected in the upper part of the filter, where a gelatinous layer forms whose contained living matter is the efficient agent. As the free surfaces of the particles of sand are out of all apparent proportion to the cubical bulk of the mass, there is a very large area upon

Sand filter

which is formed the so-called "bacterial jelly" which purifies the water. In the nature of the case the water must have access to the "jelly" very slowly, otherwise that would be dislodged and torn; hence four inches an hour is the maximum rate of downward flow. Hence also the service of a large population requires a filter of enormous superficies very carefully managed. Such a filter becomes clogged or "dead" at irregular intervals, depending upon the amount of work done, when it must be renovated first by scraping it and then by washing the removed sand. This involves using a second filter while the first is out of commission. Perhaps the chief point about sand filters that line officers should remember is the importance of maintaining their skilled staff to keep them effective in the case of military occupation.

Renewal of filters

It is a fundamental principle that no filter is automatic in its power of renovation, and that every filter requires renovation. The great sand filters just described are renewed when the receiving surface is scraped and replaced. All others, whether fixed or movable, should be readily accessible in every part, and the smaller and more portable they are the greater care they demand. A cistern for a barrack or other local supply should consist of two chambers, separated by a perpendicular diaphragm reaching nearly to the bottom. The bottom itself should be covered with a thick layer of gravel, with sand above it. The water enters one apartment and is coarsely strained by the sand and gravel through which it percolates into the other. Sedimentation occurs in proportion to the time the water is at rest. The filtering material should be renewed every three or four months, and more frequently if the water is very muddy. A fair field filter for the supply of small commands with ordinary water is a cask charred on the inside (which may occasionally be brushed) and pierced at the bottom with very small holes. Better is one barrel within another, the outer repeatedly

Cistern

Cask filter

pierced through the bottom and the inner one through the sides near the top, the intervening space filled with sand or gravel; and the whole is then properly fixed in the stream and protected from overflow. These make running, and especially muddy, water more attractive, but they are of little value when the stream is contaminated with waste. At this time the most of the minor and portable filters for individuals and small parties are disregarded, partly because of the difficulty of maintaining such apparatus with an active force and partly because of the reaction against undue dependence upon them. General recognition of the bacterial causes of disease throws discredit upon appliances, valuable as they are in their place, which serve as mechanical strainers rather than biological purifiers. The commoner filtering materials that have been used are the following: Animal charcoal (bone-black). This is objectionable because it yields nitrogen and phosphates, which favor the growth of bacteria in water. It oxidizes putrefactive organic matter, but active organic matter passes through unchanged. In other words it does not sterilize the water and may make it more hurtful. It serves as a supplying host; thus after a month's use a filtrate contained five times as many bacteria as the unfiltered water. Sponge, sometimes used in individual filters, acts only mechanically, and being itself organic soon becomes foul from the retained residuum. Cotton and wool, woven or in their natural state, are bad for the same reason. Asbestos, arranged to be replaced after purification with fire, is better for individual filters. Vegetable charcoal and coke sufficiently exclude micro-organisms (P. Frankland) but require frequent renewal. Spongy iron, the best of the minor agents, arrests suspended substances and oxidizes organic matter, but it deteriorates slowly and therefore requires renewal. The common individual filters put on the market in every campaign are worthless, except as possible strainers of mud. They soon clog

Double barrel

Individual filters

Animal charcoal

Sponge, wool, cotton, asbestos

Vegetable charcoal and spongy iron

Commercial filters

and become reservoirs of slime. To pour the water through one or two thicknesses of flannel or even muslin, which may be cleansed or renewed as required, answers as well. Both are valueless against disease-causes, and those sold in the shops are mere money-making devices that impose upon the ignorant.

Chamberland-Pasteur

Berkefeld

The best filtering material hitherto devised is unglazed porcelain, or a combination of clay with infusorial earth, and the most practicable apparatus is the Chamberland-Pasteur. It consists of a central rod or "candle" (bougie) of this biscuit through which the water, enclosed in a metal jacket, is forced by a pump, sometimes by the pressure of the service pipes. The bacteria, unable to penetrate the kaolin, are held back. But as they will ultimately grow through it if unmolested, the candle must be removed at least once a week, preferably twice, and be well brushed and boiled or exposed to a hot flame. Under such conditions this filter is absolutely efficacious. When the water is muddy it should first be passed for cleansing through some coarse filter, otherwise mere mud may imperviously coat the candle. Admirable as it is, this device is too unwieldy for the field and too delicate for the barrack. The care it requires involves the intelligent attention of a private family. The Berkefeld filter, issued to camps of concentration in the Spanish War, is of the same general type as the Chamberland, with the cylinders assembled in a battery. Turbid water, which soon coats the cylinders and reduces the yield, should first be clarified. Under pressure of 40 pounds 3 cylinders yield $1\frac{1}{2}$, 15 cylinders yield $7\frac{1}{2}$, gallons of sterile water a minute. This filter's efficiency depends upon the attention given to boiling and scouring the fragile tubes, a duty to be intrusted only to a selected permanent squad. When that work is well done, the result is admirable; with careless or ignorant men, the output soon deteriorates in amount and quality; and when men are detailed without selection, the apparatus is quickly wrecked. Properly managed, the Berkefeld filter is admirable for camps of position, but it appears certain to break down in campaign. So much depends upon the care it receives that its efficiency is an index of the intelligent interest of the officer in charge.

Darnall filter

The latest American military filter is the Darnall.* This is designed to restrain all impurities after clarification of the water in which they have been precipitated. It consists of a tank to hold the water undergoing treatment and a "siphon filter" which is suspended in it. The "siphon filter" is a half-inch galvanized-iron pipe, upon one of whose arms near its extremity is a 4-inch brass disk with a collar 2½ inches wide. A similar disk and collar are attached 13½ inches further up. Brass rods reënforced midway by a brass disk connect these collars. Below the upper edge of the lower collar the pipe is pierced with numerous holes for the admission of the filtered water, and the other arm of the siphon-pipe is fitted with a stop-cock. The whole of the apparatus which lies between and includes the collars is carefully wrapped with eight thicknesses of sterilized cotton cloth. The action of the Darnall filter depends: (1) Upon alum mechanically entangling and precipitating the impurities, including the bacteria, in the water; and (2) Upon that precipitate being held back by the filtering cloth through which the treated water strains. Any excess of alum in the water is neutralized by sodium bicarbonate contained in the precipitating powder. The tank having been nearly filled with water previously charged with the precipitating powder, the filtering apparatus is suspended within it and when the siphon has been set in action by a small pump, the treated water will escape at the rate at first of 2 gallons a minute. This rapidly decreases as the cloth becomes clogged, so that the ordinary output is 25 gallons an hour. The cleaner the cloth, the more rapid the flow. Clear water passes at the rate of 50 gallons hourly. It is believed that this process eliminates 98 per cent. of the bacteria. Crated, this filter

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* Devised by Major C. R. Darnall, Medical Corps, U. S. Army.

weighs 52 pounds. In emergency and for detachment use it may be subdivided and reduced to 18 pounds (exclusive of the powder), and the parts may be distributed for transportation among several men. It would appear that the whole apparatus might be carried on a pack-saddle, although this does not seem contemplated in the instructions for its management. To operate the filter requires two trained men and, as with other efficient purifiers of water, such service more than compensates for their absence from the firing line.

British field filter

At this writing the British army in the field depends on first straining out or clarifying the water by " coarse sponge closely packed under pressure in a chamber, while the filter itself is a tube of specially prepared hard clay having a central tube of perforated zinc." * This apparatus is variously arranged in batteries for transportation on wheels, on pack-saddles, or by coolies. The final principle is the same, but the actual working appears to be more successful than that of the Berkefeld filter. It requires so much care in its operation, that it is not intrusted to regimental troops; so that, except to illustrate the principle, it is beyond the scope of this work. It would appear, however, that men of the line, or at least of a competent service corps, might be charged with its manipulation in our army.

Ishiji filter

The latest device used on an extensive scale in the field is the Japanese "Ishiji" filter, which consists of an inverted canvas cone that has two funnels which open a few inches from the apex. These funnels, tightly filled with compressed sponge and granulated charcoal, are the filtering agents, and of course their contents must be frequently renewed. The mouths of these funnels are tied until the water in the large cone has been treated by chemicals, after which they are opened and it escapes through them. According to Firth, to twenty-five gallons of water are added four ounces of a mixture of potassium permanganate, potash alum, and

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* Notter and Firth, *Hygiene*, 3d ed., p. 925.

kaolin, and two ounces of a mixture of kaolin, aluminium chloride, carbon, and a little vegetable extract. Stirred together in the water these remove its turbidity by precipitation and destroy 90 per cent. of the bacteria. The proper proportion of the powders to the water can only be determined for each quality of water by experiment, the measure being the amount required to redden it. Ten minutes after the color has gradually disappeared, the water may be used. The 25-gallon cone may be emptied twice an hour, but manifestly there will be risk if the filtering sponge and charcoal are not frequently replaced.

Sterilization by heat

The sterilization of the water by heat without transforming it into steam, either at all or for more than an instant of time, is effected when its temperature touches the boiling point or is maintained at 180° F. for fifteen seconds. Either condition destroys the hurtful bacteria. Several machines have been devised for this purpose, of which the Forbes-Waterhouse apparatus, formerly supplied the army, is a type. This has been replaced by the improved and lighter Forbes sterilizer. After the incoming water has been raised to the required point by a flame, it parts with much of that heat by conduction to an equal volume of freshly admitted water, separated from the heated water by a thin metallic diaphragm. The economy as well as the efficiency of its operation depends upon the conservation of that force. At the very time that the incoming water receives the heat from the water previously introduced, the latter is cooled in the same degree. The new water therefore requires less additional heat to raise it to the standard of sterilization, and the water already sterilized is more easily reduced to a potable temperature. When furnished as a stationary apparatus it has an excellent reputation for the service of office buildings, schools, and factories; and it should be available for barracks where there is no adequate supply of unimpeachable water, provided the deposit of salts where hard water is used does not choke the tubes. For field

Forbes sterilizer

use the large Forbes sterilizer, which has a nominal capacity of 148 gallons but has developed on an official test nearly 400 gallons an hour, is mounted on stout running gear, and drawn by four horses could probably pass wherever a limbered field piece would go. Over heavy grades or across country six horses would be required for draught. It is not designed to carry the raw water, which must be supplied to it from without, and its weight with the necessary fuel and a driver of 150 pounds would be 4,175 pounds. Should it carry a full charge of sterilized water, as a reserve for issue at a halt where there might be none to be acted upon, the weight would be 1,200 pounds more. A smaller apparatus in a steel field case is furnished for transportation in an army wagon. With the case this weighs 96 pounds, and it has a nominal hourly capacity of 25 gallons, which is exceeded in the factory test. It carries one gallon of oil, which should sterilize 300 gallons of water. The container of a third field type is barrel-form, one barrel being nested within another for carriage. In operation the larger barrel holds 49 gallons of raw water, and the smaller one 22 gallons of sterilized water as prepared by the apparatus. Packed for the road this weighs 134 pounds. A wood-burning attachment, 10 by 10 inches in size, weighing 42 pounds, is also supplied. It does not appear that the Forbes has been prepared for carriage on a pack-saddle or by a bearer.

Objections to field filters or sterilizers

The radical objection to all water-purifying machines intended to accompany troops, is the number an active command would need and their liability to be deranged or not to be present when most needed. Generals and quartermasters alike are justly jealous of increased trains, especially when they are expected directly to accompany brigades and divisions. Presumed exigencies often make it difficult for even the ambulances to hold their position in the column. When units are subdivided, as detached service so often compels, sterilizers, unless in superabundant reserve, cannot accompany every subdivision. In all cross-country, jungle, or mountain service, the problem of such supply grows. In an effort to overcome some of these difficulties of weight and immobility, it is understood that the Forbes company may attempt the manufacture of a sterilizing apparatus embracing the same principles as the large sterilizer, but adapted to a two-wheeled limber with standard army wheels and axles. This would be capable of sterilizing from 400 to 500 gallons an hour, and the whole apparatus and its limber should not weigh more than 1,800 pounds and could be drawn by two mules or, in emergency, be attached to a gun-carriage. With this would be a folding water-proof canvas tank, with a capacity of from 1,000 to 2,000 gallons; but sterilized water would not be carried on this limber. Where dry camps are anticipated independent water-wagons should distribute sterilized water from these temporary canvas reservoirs.

Lighter Forbes sterilizer

Notter and Firth speak very highly of the Griffith sterilizer, which also depends upon the action of heat. This is an English apparatus which yields from 60 to 350 gallons of water an hour, according to the type. A theoretical doubt arises as to its competence under all conditions because, as described by Notter and Firth (p. 929), of the dependence placed upon an automatic " valve which controls the passage of the water from the heater to the cooler." Speaking generally, however well such contrivances operate in fixed camps, they are liable to frequent derangement under the conditions of the field and occasionally when they are stationary. Although lighter than the original Forbes and more mobile because mounted on a two-wheeled running gear, the Griffith sterilizer also seems open to the serious objection of being unable to maintain close connection with moving troops when most required, especially with active infantry and perhaps with raiding cavalry in a difficult country. Where pack trains replace vehicles, the immediate need would be for a pack-saddle sterilizer. This has not yet been devised, notwithstanding the English seem to have a filter which may be so carried.

Griffith sterilizer

Care of sterilizers

If sterilizers or complicated filters are to be used, their efficiency must be maintained through manipulation by men from a Service Corps, or by permanent regimental details. The latter weaken the firing line and diminish the number of men under arms; but unless such details are carefully selected and have a degree of permanence, the apparatus runs great risk of damage. Nevertheless, the need for pure water is paramount over most other requirements, and it is better for a few good men to be out of ranks upon this duty than for many to be on sick report. A sterilizer deserves as careful and intelligent inspection as a machine gun, and it is best kept in working order by appeal to the pride and rivalry which, with discipline, keep other military instruments in an effective state. If the responsible officers ignore it as beneath their dignity, it will certainly be damaged by the men's neglect; and the ultimate penalty will be paid through an increased sick list when emergency arises.

Thirst

In its final analysis the desire for water is a physiological demand, difficult to regulate and impossible to set aside. True thirst represents an essential want of the system, to alleviate which water is a necessity, not a mere gratification. Water, especially under exertion, is constantly evacuated by every channel. It escapes from the blood through the perspiratory glands and the kidneys, sometimes from the bowels, and in extreme cases even the lymphatic fluid, which maintains the moisture and flexibility of the muscles, is diminished. This must be replaced, and if good water is not at hand any water will be drunk. It is here that discipline asserts itself and here the resources of officers and men are best called in play. An admirable illustration, which may always repeat itself in contaminated regions, occurred in the early days of the Philippine pacification, when a mixed command of a regular battery and a battalion of volunteer infantry made a ten days' reconnoissance, with orders to drink no water not freshly boiled. The regulars were held to the requirements

Boiling for self-protection in the field

as a matter of course and returned with no sick. The volunteers followed their own judgment, on the assumption that they could recognize good water when they saw it, and were ravaged with dysentery. It is by no means true that every well is contaminated or that all running water even in inhabited regions is dangerous; but like other training it is better that the men should learn to boil their drinking-water as a matter of routine, so that the operation may be conducted intelligently and almost automatically when in the field. A great value of weak tea or coffee as an habitual beverage in the field is the assurance that it is sterile. When sterilizing tanks are available for the general supply, well and good. But because they cannot be depended upon, the men should carry on the person boiled water with or without such flavoring. When a canteen is devised in which water may safely be heated to the sterilizing point and be conveniently cooled, it will be a long step forward in the prevention of water-borne disease. For ease of transportation and vigor of combustion, denatured alcohol would appear to be a serviceable personal fuel for this use. Under the stress of conflict this care of health yields to more urgent duty. But those occasions of direct fighting are exceptional; it is the march and the bivouac that are the more constant dangers, and Port Arthur demonstrated that sanitary water can be furnished a great besieging army.

Canteen sterilizer

In the field the water-supply, whether it is to be purified or not, should be guarded and if the quantity is small it is to be carefully conserved. The very first duty even at a temporary camp is to post sentinels over the water. These are always to check waste, and when it is supposed to be unwholesome, to prevent any being taken for drinking purposes except by authorized persons for sterlization. The margin of a stream is quickly trampled into mud and the water roiled and made turbid, unless an artificial border of wood or stone is promptly laid. A water-supply is so easily spoiled that an officer should be in immediate charge

Care of field supply

Wells and springs

To measure flowing water

To save water at night

Quantity per capita

of the whole, where it is at all limited as compared with the demand upon it. All unprotected wells and springs should be banked at the mouth against drainage into them and against waste. When a small spring is moderately dug out and encased, or a headless barrel sunk in it, the visible supply is much increased. Detachments using a small stream should be careful that the supply for the animals and for police purposes is taken out in that order below the drinking-water station. If the stream is shallow, temporary dams to create small reservoirs should be made. Horses drink better and more rapidly where the water is at least five or six inches deep, which can easily be arranged. The quantity of flowing water available during a given time may be roughly estimated by first measuring the speed in inches with which it carries a light object per minute and multiplying that by the mean depth in inches. If this product is multiplied by the width of the stream in inches and divided by 231, the quotient is the number of United States gallons that passes a given line per minute. Where, in a camp of any permanence, the command is large in proportion to the water-supply, it is expedient to save the water which passes at night and otherwise would be lost. To do that, make reservoirs from which to draw the drinking- and cooking-water. Then extend a single or double row of sunken half-barrels, all connected by little gutters to avoid waste, for the animals, and conduct the surplus into a still lower reservoir. On the march a man requires for drinking and cooking six pints a day, increased in hot climates to eight, and an equal amount for washing the person. In stationary camps he needs 5 gallons for all purposes. In barracks for all purposes except water-closets and bathrooms the allowance should be 10 gallons a head, and with those conveniences 25 gallons. Hospitals require several times as much per man, depending on the character of the cases. A horse ordinarily drinks at one time about

1½ gallons in about three minutes, and each gulp represents about 3 ounces or a little less than a fifth of a pint. If allowed all they will drink, horses will require from 6 to 10 gallons of water a day and about 3 gallons per head for police purposes. All the foregoing figures are the lowest.

For horses

The importance of not defiling any water is so nearly self-evident that it is almost incredible that in 1861 an essay circulated by one of the great commissions organized for the benefit of volunteers, advised placing latrines over running water when possible. Fortunately this was corrected in the next edition, and it is cited only to show that the importance of guarding all water is sometimes strangely overlooked. Munson reports that that very error was committed by raw troops in the Spanish War. No apology is made for repeating from *The Reference Handbook of the Medical Sciences*, 1886 (1st ed., iii, p. 756), this injunction: "Nothing is better established than that no refuse, and especially no fæcal matter, should be discharged so as to follow a stream either directly or indirectly, unless it be one of the great rivers and then only when it is certain that the water is to be used by no one within a reasonable distance. It is suicidal to pollute small streams that may possibly supply our own forces, then or later, and it is criminal to spread diseases in that way among a civil population, or . . . to an enemy."

Pollution of streams

Snow is more impure than rain in the same region. It takes up foreign substances freely from the air through which it passes, and absorbs them from the soil on which it lies or when they have been thrown upon it. Snow-water, especially in densely inhabited regions, equally with other doubtful water should be sterilized before consumption. Water is partly purified by freezing, but so imperfectly as to require the sources of ice-supply for domestic use to be carefully selected and guarded. Clear ice, even from polluted water, may contain but a small proportion of hurtful

Snow and ice

matter, because during the comparatively slow process of natural freezing the impurities gradually gravitate below the ice-sheet. But snow-ice and that made by flooding ice-fields may be very impure. As bacteria make their way to air-bubbles, "bubbly" ice is particularly dangerous as compared with the solid blocks, and where thin sheets are artificially combined, those which had been superficial are apt to be contaminated. Vicious, as well as beneficent, bacteria easily survive a freezing temperature for the time, but Sedgwick and Winslow have shown that they gradually succumb to prolonged storage in an ice-house, that is to severe long-continued cold. It may therefore be assumed, as Professor Godfrey has pointed out, that, with the exterior layers carefully eliminated, well-stored ice is reasonably safe; but on the other hand good ice may become superficially contaminated by exposure to filth and aërial dirt and by unclean handling while in transit to the consumer. That ice is artificial, unless made from freshly distilled water, is no evidence of its sterility. It may be more impure than natural ice from the same water. In view of these constant risks, it is always better not to place ice in direct contact with food or drink.

XXVIII

WATER AS A DISEASE-BEARER

Water-borne diseases

Plymouth, Pa., typhoid epidemic from water

Several grave diseases which at times ravage military commands are intimately associated with water as a cause-bearer, if not as a cause. These are cholera, typhoid fever, and a variety of dysentery, which are spread by intestinal discharges from infected persons and, as a rule, gain access to the new victims through food and drink. Contaminated drinking-water is not the sole agent of propagation of any of these; but it is the most common, especially in epidemic outbreaks. Just how typhoidal and choleraic discharges enter any drinking-water may not be demonstrable, nor even when present can their bacteria always be isolated; but it is certain that defiled water is a principal agency in the spread of those diseases. Hence, without waiting to prove actual contamination, the risk of that possibility demands unceasing vigilance in the exclusion of all waste or the habitual and complete sterilization of any suspected supply. There is nothing in the taste or appearance of water thus corrupted to excite suspicion, and as both typhoid fever and cholera usually begin with a painless diarrhœa whose import the invalid does not understand, it is quite possible for such discharges to drain indiscriminately and unwittingly into any but the best-kept water-supply, so that epidemics of great magnitude sometimes arise in this way. A well-authenticated example, among many others, is one where the discharges from a single case, cast upon the bank of a stream, were carried by melting snow into the water which supplied the reservoirs of a town of 8,000 inhabitants. There followed an epidemic of 1,104 cases of typhoid fever which resulted in 114 deaths and enormous loss in labor, besides the expenditure of much money and the infliction of great anxiety and distress. Those citizens whose water came from other sources escaped. Two factories in another place that employed many hands stood side by side, but the men drank from two distinct wells. One of these wells was pure and the other was believed to be infected. Of those who drank from the infected well 600 died of cholera. Among those who used the other well there were no cases. British Indian experience is full of examples where regiments drinking infected water were ravaged by cholera, while those who used clean water escaped. Drinking-water known to be specifically contaminated spreads dysentery freely, and a severe and fatal variety of dysentery has repeatedly been traced to impure water not recognized as charged with dysenteric products but contaminated with fæcal impurities. On the other hand wide-spread diarrhœas have ceased when the general water-supply has been changed to one that is purer.

Cholera epidemic from water

Dysentery and impure water

Water contaminated with animal waste is not necessarily disagreeable, but is apt to be sparkling and may be pleasant to the taste. Although one would not willingly drink even highly diluted sewage, it is nevertheless a fact that sewage-tainted wells may not induce disease. The risk lies in the liability of the unrecognized sewage to acquire a specific taint without the physical characteristics of the water changing. That wells occasionally derive a part of their supply from neighboring cesspools, appears from authenticated instances where they have been reduced or exhausted when those receptacles were abandoned. And as water containing the product of such waste is usually clear and sometimes more palatable than that in good wells, it is difficult to convince persons accustomed to its use of its true character and, particularly, to make them understand how leakage may enter over long and unsuspected routes. Supplies that are the most dangerous in fact, not the worst in appearance, are the unsus-

Sewage-tainted wells

pected; for had they been suspected their use would not be persisted in. The following examples of the contamination of water from a distance might be repeated under varying conditions: A well nearly free from iron suddenly began to yield chalybeate water which deposited an ochreous sediment. It proved that a quantity of spoiled beer had been poured into the ground 115 feet from the well, its organic matter acted as a reducing agent on ferric oxide normally in the soil, and this becoming dissolved as a protocarbonate entered the water that supplied the well. This bore the coloring matter that betrayed its presence, but it might quite as well have been colorless but infected sewage. Gas from a main 1000 feet away has been recognized in well-water. The typhoid poison has been conveyed several miles by an underground and previously unsuspected flow, as at Lausen in 1872. In this instance a hill 300 feet high stood between the source of the infection and the scene of the outbreak. The determination of probable sources of water-infection is one of the functions of sanitary officers; but a competent knowledge of this subject should also be part of the working equipment of an officer of the line, partly that he may undertake original investigation on occasion, but chiefly that he may appreciate the significance of this form of advice.

Distant contamination of water

It is not practicable, as is popularly supposed, to determine off-hand or indeed without elaborate laboratory processes, whether or not a particular water-supply is infected by the commoner pathogenetic bacteria. Indeed Notter and Firth say,* from their own experience, that "the qualitative bacterial method of examination of a water is about a thousand times more delicate than the chemical method." In practice the question in relation to suspected water reduces itself to one of probabilities, with the chances in favor of infection by the typhoid bacillus in populous countries; with no prospect of cholera outside of the cholera range; and with a fair certainty of the

Detection of disease-causes in water

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* *Hygiene*, 3d ed., p. 107.

presence of both the specific causes of the two conspicuous types of dysentery in tropical and subtropical climates. The lesson of avoidance is obvious. These disease-causes are only discernible under the microscope after prolonged and very careful preparation and may not be extracted for observation by filtration, nor do they respond to chemical tests. But there are chemical tests by which sewage may be inferred, such as determining the presence of chlorides, of nitrates, of nitrites; and if sewage is there, it may carry bacteria. Should a suspected well materially differ chemically from neighboring wells, it is probably infected; in which case the chemical condition is a sign, not a cause. Should a chain of wells agree in their variation from the presumed norm, special investigation should be made for the channel of communication. The simplest process is to introduce into the cesspool or other suspected premises a quantity of salt or strong brine and later to observe what change, if any, there is in the observed chlorides in the well. If these have increased, the inference is obvious that some of the contents of the vault also enter the well in solution. A more delicate test than salt is lithia, which is foreign to ordinary soils. Chlorides in excess ordinarily imply their derivation from urine, and nitrates and nitrites indicate organic decomposition, in this case presumably of sewage. The nitrites would mean that the organic waste has been incompletely oxidized and that the process is still in operation. (These might be derived from a perfectly innocent source, but that should be established before it is admitted.) By themselves, like CO_2 in the atmosphere, these nitrogen compounds are harmless unless they are in enormous quantities. But they are an index of possible accompanying evil and may explain the occurrence of typhoid fever, cholera, sometimes dysentery, if either has attacked the water-consumers, because the sewage that they should show to be present will then be charged with one or the other of those intestinal poisons. The ordinary rural well sometimes is

Suspected wells

Significance of chemical evidence

poisoned by infection making its way through the soil, especially along rifts below and in the surface; but it is more apt to become infected, as Sedgwick claims, from the top. Poorly curbed or loosely covered wells may be polluted in numerous ways, the opportunities multiplying with the density of the population and the age of the settlement. But until specifically infected, specific diseases will not be due to the well. The military application here is to remote posts and to the camps and marches of real and mimic war. It is manifestly unwise to assume that infected dejecta discharged upon or buried in the ground will certainly be neutralized before they reach a neighboring well, particularly if the soil be light or sandy, the more as it is impossible to determine that no rift allows direct communication with the water. Nevertheless the best authorities look upon the chance of such indirect infection as very small. Still Vaughan has discovered organic matter in the soil on nearly level ground 50 feet from a privy-vault and apparently derived from it; as comparison with similar soil where there were no known sources of contamination seemed to show. And such vagrant material might be infected. The typhoid cause may persist in unfiltered water for thirty days, but it usually perishes very much sooner. The cholera cause has a relatively short life in water, except as it is reinforced from without. In the presence of saprophytes (bacteria living upon dead matter), disease-producing bacteria usually disappear quickly from contaminated water; and where a sand filter is used the specific organisms are eliminated by becoming entangled in the "bacterial jelly." In most cases of water infection, however, the cause is a continuing one, depending upon the incessant addition of new material, and the proper policy is to seek and remove the cause rather than to attempt to neutralize the consequence. Uncontaminated water is one of the foundations of health.

Domestic wells

Longevity of germs in water

Besides these microscopic forms of lowly vegetable and animal life, intimately associated with the water we drink and powerful to develop defined disease each after its kind, water may hold in solution or suspension other foreign matter, inorganic or organic. The minerals usually appear in natural solutions, as the salt of the sea and the ingredients of springs therapeutic or hurtful as the case may be. Distillation is the most summary and radical form of relief, if such water must be used in emergency. The organic contents are impurities introduced by accident, as sewage, already discussed, and other forms of waste or even of decomposition, as the soakage of graveyards and of vegetable decay. Disease thus set up is chiefly the consequence of irritation, occasionally of poisoning by ptomaïnes; and against all organic life sterilization by heat is most effective. But even boiling, while it destroys the bacterial life with which decaying matter teems, will not redeem decomposition. The presence, not the amount, of organic matter in water may be roughly determined thus: Half fill a quart bottle with water warmed to 70°–80° F.; shake it vigorously, and if a bad odor is detected it is doubtful or bad. But not all bad waters give out odors, and the natural sulphur waters are offensive without being harmful. Therefore evaporate 3 or 4 ounces to perfect dryness in a platinum or porcelain capsule, and then ignite the dish. If there is no blackening or only an easily dissipated darkening of the residue, the water is probably good. If the crust blackens, there is probably carbon from an excess of vegetation. If nitrous fumes are evolved and the carbon sparkles with energy, animal matter may be suspected. Or the permanganate test may be used. The permanganate salts are rich in oxygen that is easily given up. Potassium permanganate added by degrees until its oxygen is absorbed, colors the water to a rich pink or red. From the amount required to tinge the water permanently, an estimate may be made of the quantity, but not of the kind, of organic matter. This test applies equally to beef soup and street filth. Such tests are not expected to be made by company officers where

Organic and inorganic contents

Detection of organic waste in water

the Medical Corps is present. But they are very simple, and for their own assurance when they may be absent on exploring or other duty without an attached medical officer, subalterns of the line may well rehearse them in garrison under the guidance of an expert.

Disposal of organic waste

But in view of the inconceivable amount of organic disintegration perpetually in progress in the soil, why is not all water a mere vehicle to carry this waste, becoming more and more saturated with the lapse of time? Because the free oxygen in the soil-air and in the water allows unrestrained oxidation, and because certain minute organisms, generally associated with mineral matter and known as the bacteria of nitrification, decompose the waste and set free ammonia. Should the albuminoid ammonia (which is chiefly derived from decomposing vegetation) exceed 0.01 per 100,000, or free ammonia (obtained from urea or other easily decomposable animal substances in solution) exceed 0.005, the water should not be used.* From this ammonia, first nitric acid and subsequently nitrites and nitrates are formed. These nitrogen compounds indicate that animal waste has been present. The nitrites mean that complete oxidation has not yet occurred and that danger may be present. The nitrates show that the power for evil has gone. Their proportion is an index of the amount of waste thus neutralized. But more may follow too rapidly for the soil to dispose of, or it may already be present in excess. Such indications of former disintegration, if not of earlier danger, should lead to the suspicion of present danger; for concentrated waste, for example in the shape of sewage, constantly discharged upon a limited area must ultimately overcome local regenerating influences. The nitrates should not exceed 0.35 per 100,000.

Significance of nitrites and nitrates

The sanitary disposal of sewage upon the land is important,

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* Chemical analyses would not be undertaken by line officers, but these limits are noted as a standard for the comprehension and comparison of analytic reports that may be made.

but for its discussion reference should be made to special treatises. It is always to be remembered, however, that when poured over a circumscribed tract its consecutive distribution through successive areas is essential. But what becomes of the vast quantity of sewage as well as of individual body-waste still poured, in contravention of sanitary propriety, into running streams, often those which sooner or later furnish drinking-water for communities? It is commonly said, and formerly was seriously taught, that streams purify themselves automatically. That is an error. Dilution has much to do with the apparent disappearance of sewage. In a large river the volume of water is very great and the sewage becomes immensely attenuated. The constant addition of practically uncontaminated ground-water steadily increases the dilution of any fixed quantity of sewage, and each unpolluted affluent assists in that dilution. On the other hand every community that intrudes its waste into the water disturbs the proportion and increases the difficulty of the problem. But even specific organic particles do disappear in some way, and the anticipated accumulation of deadly poison does not occur. The process is substantially as follows: All natural water holds in solution some free oxygen, and this plays its part in the oxidation of the waste. Where there are rapids probably more oxygen is entangled, although, contrary to the older opinion, it is now believed that swiftly running water does not purify itself as quickly as that which moves slowly or is at rest. The immersed solid matter is acted upon by the bacteria of decomposition. Literal sedimentation occurs in proportion as the water is quiet, and practical sedimentation happens when the suspended silt envelops swimming particles of sewage. Light is germicidal and affects the vicious bacteria within its range, and those that are drawn to the bottom gradually give way to cold and imperfect nourishment. Still with all these favoring agents Mason believes* that the

Sewage on land

Sewage in streams

Decrease of pollution

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* *Water Supply*, 1st ed., p. 187.

percentage of pollution in a running stream to disappear continually decreases per mile of flow, and Sedgwick[*] lays down the rule that "no river, unless from an absolutely uninhabited watershed, is to be regarded as suitable for direct use as a public water-supply." The military moral is that permanent garrisons and camps for a night on the bank of a river, alike, may not trust the water at their feet until it has been rectified through sanitary art. The water of a lake is somewhat different, and a small community may use such a quiet reservoir provided no polluted current flows toward or near the intake.

Military water-supply

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[*] *Principles of Sanitary Science,* 1st ed., p. 233.

XXIX

PREVENTABLE DISEASES: MALARIA AND YELLOW FEVER

Malaria

Plasmodium malariæ

Anopheles

Mode of infection

Individual precautions

Aromatic oils

Malaria, literally meaning bad air, has gradually come to signify a disease or a class of diseases. It is recognized that a parasitic micro-organism, an animalcule known as the *plasmodium malariæ*, is its cause. These *plasmodia* (for each of the several varieties of the disease has its own parasite, differing in intensity of effect) have not yet been isolated outside of living bodies, so that their absolute origin is undetermined. But for practical purposes it is sufficient to understand that a genus of mosquitoes known as *anopheles* (or the *anophelina*) acts as an intermediate host for the parasite, which completes its development in the red corpuscles of the human blood. The female mosquito while feeding upon the blood of a malarial subject takes the parasite into her own body, from which, after further development, it passes into man by way of the salivary glands of the insect when the new subject is stung. By no means all the *anopheles* are infected, but whenever they receive the parasite from a malarial subject they become agents for its spread. A man must harbor the *plasmodium* before he suffers from the disease. Hence the first precaution is addressed to the individual. He is to protect himself from attack by the careful use of netting, or to repel the insect by constant application of the pungent aromatic oils, as pennyroyal or eucalyptus, to exposed parts of the person. Such application is domestic, a temporary procedure impracticable for large commands, superfluous in any case where the first is scrupulously carried out,

Head net

Screening of persons

Screening of buildings

but effective within its conditions. The protection of the head and neck by a net while actively engaged in out-door exercise is perfectly within the experience of sportsmen in the North Woods and Canada and of the Japanese in their Manchurian campaign. This is distinctly defensive armor, whose use must be enforced in the presence of that enemy. Collective defence is the systematic screening of habitations, from tents to barracks, including every form of shelter within the dangerous regions. The mosquito bar is a mobile guard carried with the command and, as now arranged, applicable to beds in barracks and to shelter tents alike. When intact and the mosquito itself is not also enclosed, it is a perfect protection. Because its use is sometimes inconvenient inexperienced men may attempt to evade it, which is a matter for discipline. The offence usually enforces its own penalty as well. The least damage to a mosquito net, like a leak in a dam, is to be immediately repaired. The whole of permanent barracks and quarters in tropical malarial regions should be systematically screened by rustless wire. In the older structures this is most effectually done by constructing within each apartment a wire cage of equal capacity, which has the further advantage of excluding flies. New buildings may be, and in fact are, arranged so that communications with the outer air alone are screened. In each case mosquito curtains for the beds remain a necessary precaution. It is hopeless to extend such protection to the bamboo huts of the tropical natives, whose open-work floors are a part of the scheme of their domestic economy for the disposal of sweepings. Screens of whatever material unquestionably check currents of air, and on that account are trying in hot and humid climates. Notwithstanding the strong temptation to discard them with the plea for better air, their use must be enforced under the penalty of probable illness.

Within a barrack or other dwelling individual mosquitoes resting on the ceiling and sometimes those upon the walls may

Vapor

Pyrethrum

Campho-phenol, sulphur

Formalin

Hibernation

be destroyed by cautiously holding under them a small vessel (as the top of a can on a light pole) containing a little household ammonia, mineral oil, or spirits of turpentine. The insect is stupefied by the vapor and falls into the vessel. Pyrethrum (insect powder) burned at the rate of 2 pounds to 1000 cubic feet will clear an apartment of mosquitoes, which fall inert to be destroyed by other means. In the Panama Canal Zone equal parts by weight of camphor and carbolic acid (campho-phenol) vaporized by heat is the most effective insecticide. The very dense soot that it otherwise deposits requires the use of a special apparatus. Burning sulphur is always lethal, but as it decolorizes some fabrics and stifles all respiration it must be used with caution. Formaldehyde has a disputed reputation, but probably is useful. In non-tropical climates the mosquito, usually the impregnated *anopheles*, hibernates, awaiting the season for the renewal of life. Giles, quoted by Abbott, "makes the valuable suggestion that during the hibernating season all buildings likely to harbor them [particularly the eaves of barns, houses and out-buildings, as well as their interiors] should be thoroughly renovated, lime-washed, and fumigated with sulphur."

Breeding conditions

It is insufficient merely to kill the adult. The real control of this disease-breeding pest requires acquaintance with its life-history and an industrious application of that knowledge to simple agencies. All varieties of mosquitoes are alike in certain general characteristics, so that for the purposes of this work it is useless to differentiate between species. The eggs are hatched in still, generally stagnant, water. In both its larval and its pupal stage the insect must breathe at the surface of the pool. If there is no standing water, or if the air is excluded, there will be no mosquitoes. Hence a locality may be protected by drainage or by covering the standing water with an air-proof sheet of oil; for as a rule

Difficulty of extermination

mosquitoes do not fly far, although sometimes they are blown considerable distances. It is true, however, that adult mosquitoes may be transported to remote points in boats and railroad trains. The practical difficulty in their extermination comes from the rapidity with which the swarms develop and the surprisingly small quantity of water any particular brood requires. Under favorable conditions a batch of several hundred eggs hatches within a few hours, the mosquito may fly within ten days, and she may lay her own eggs three days afterward, so that a fortnight will complete the cycle. A cupful of water, the quantity that lies in an animal's foot-print, a very little in an otherwise empty can, supplies a breeding-place. The warmer and rainier the locality, the more facile the multiplication. These breeding-places may be accidental depressions in the earth, bottles or cans carelessly exposed, uncovered rain-water receptacles, gutters out of level at the eaves or on the surface of the ground, any recess where a few spoonfuls of water may lie. In fixed localities, with a sufficient working force operating under the systematic application of military methods whether employed by soldiers or civilians, the propagation of the mosquito may be reduced to a minimum, as the remarkable work of Ronald Ross and Colonel Gorgas under most unfavorable natural conditions illustrates. In Gorgas's own words, "by far the most important [measure for the extinction of mosquitoes] is that of destroying the breeding-places, and this is successfully done by surface and subsoil drainage." But transient camps and moving columns must rely upon exclusion more than upon extinction.

Malaria from malarial cases

After all, the mosquito is simply a transferring agent and the malarial subject, not always a patient, is the distributing centre. With our present knowledge it appears that, if all malarial cases were made well by the destruction of the parasite within the body through the use of quinine, the supply of the infecting material would be exhausted. In fact as it stands by no means all *anopheles* are *plasmodium* carriers, for they are found over large areas free from this taint and become infected as they draw blood from human beings already sick. This presents three lessons:

Keep mosquitoes from the sick

First, that every soldier whose blood contains the *plasmodium* must not only be retained on sick report until it is free, but he must be screened from access by mosquitoes for their sake rather than for his. Of course this refers to localities where the *anopheles* is present.

Destroy plasmodium by quinine

Secondly, that to all residents within the malarial range should systematically be administered adequate portions of quinine, which arrests the development of the *plasmodium* within the system. It would be theoretically possible to abolish the disease by destroying the parasite, so that the mosquito would be deprived of this infection; for it is always to be remembered that it is not the natural virus of that insect which creates the disease, but the poison that is injected along with it.

Infected residents maintain malarial reserve

Thirdly, that infected residents, perhaps themselves not very sensitive to its effects, maintain a constant reserve of the *plasmodia* whence others may become infected. The disease has been introduced into previously exempt communities in just that way.

Infection of Mauritius

Thus, about 1865 it was carried by infected coolies to the Island of Mauritius, hitherto free from it, and practically the entire population was consecutively attacked by the disease which established itself there. An isolated or limited community, like that of an island, should be able to prevent its spread by destroying through clinical means the *plasmodia* in the blood.

Dark races not immune

Notwithstanding the dark-skinned appear to be less seriously affected than the white races, they have no real immunity, as sometimes supposed, against the malarial poison.

Filipinos agents

In nearly all the Filipino scouts, even when apparently well, the parasite is present, and the mosquito readily transfers it from them to the associated white troops. As it is morally impossible to enforce the preventive use of nets among them, these men

Increased susceptibility to malaria after earlier attacks

Exclusion of malarial cases

should by order be constantly under the curative or the prophylactic action of quinine on their own account and for the sake of other soldiers. Malarial attacks increase susceptibility and lessen the power of resistance to subsequent ones. Thus it was the rule, not the exception, that officers and men who had been wrecked by the malaria of Cuba in 1898 speedily broke down from similar causes in the Philippines in 1899. It would be good routine administration to require a blood examination of all men under orders for regions known to be seriously malarious, and to exclude as suspects all whose records are not clear. Little is less futile than to fill a command with men sure to become incapacitated, unless the emergency is grave enough for them to be sacrificed for the attainment of an immediate end.

Mosquito theory

Control

Whether the mosquito is or is not the exclusive agent of infection, or whatever may ultimately be discovered as the primitive habitat of the *plasmodium* and concerning its life in the absence of its human host, the common and effective agency of the *anopheles* in distributing the disease has been conclusively demonstrated. It is a fair generalization that where there are no mosquitoes there will be no malaria. Besides the logical and physical proofs, long-recognized but previously uncorrelated facts are satisfied by this theory. Thus, the malarial poison appeared to be borne for limited distances by the wind, to lie comparatively near the ground, to be stopped by mechanical barriers, to be associated with warmth and stagnant water and to be inhibited by continuous frost, to be avoided at least to a degree by residence in an upper story, to be most effective when the exposed person was ill-clad, and to be much more active at night. It follows that if explanation and advice are not heeded, authority must interpose to enforce the use of nets as a guard against the mosquito, to require proper medication, and to punish unnecessary exposure.

Soil theory

Dangerous localities

Boiled water

It has not been scientifically demonstrated, but the conviction is widely spread among residents of the tropics that the malarial cause has its primary and fertile seat in the soil and that it may be taken into the system with unboiled water. Disturbance of the earth in particular localities, whether for agriculture or mining, especially in the absence of direct sunlight, may be followed by outbreaks of malignant disease, and to tarry even over night near the ground in such districts, notwithstanding the protection of the mosquito bar, is regarded as a direct challenge to death. This traverses the doctrine of the laboratory, but in deference to it as the apparent dictum of experience, which it is seldom wise to reject, the use in those localities of boiled drinking-water, preferably as tea or coffee, is commended. Indeed Harrington, an excellent authority, remarks "it is regarded as not impossible that the drinking of water contaminated by [mosquitoes] . . . may have a part in the dissemination" of malarial fever. To boil the water would devitalize the *plasmodium.* If there must be residence, as for outposts, there should be broad slashings and thorough destruction of the immediate jungles to admit sunlight, and minimum disturbance of the soil. It is self-evident that where any malarious districts must be occupied or traversed, troops should be the least exposed at those hours when the mosquitoes are most active.

Yellow fever

Stegomyia

Yellow fever is a disease of navigable regions in hot moist climates that, as a rule, does not twice attack the same person. Walter Reed brilliantly demonstrated, positively and negatively, that it is propagated, and propagated only by the mosquito. The female of the *stegomyia, calopus* (formerly *fasciata*) is the intermediate host for the specific agent of this disease, as the *anophelina* are for the malarial cause. The exact cause is yet undetermined, for it is ultra-microscopic and is not restrained by the porcelain filter which stops discernible bacteria. The *stegomyia* is essentially a domestic mosquito confining itself to residences, including ships, and to a very narrow margin beyond, and not flying abroad like the *anopheles* and *culex*. The prevention of the disease consists in the destruction of mosquitoes that have been or may become infected, for there is no other mode of communication. Gorgas has proved such extermination possible even in so vast and fertile a hot-bed as Havana, and has repeated the feat in the fever-ridden Canal Zone. No mosquito should be allowed to reach a yellow fever patient, who should be carefully screened, nor having entered the apartment, whether having become infected or not, to escape from it. Besides there should be unremitting destruction of all mosquitoes, whether infected or not. We are relieved from the ancient dread of yellow fever by the modern knowledge of its natural history. As heretofore, it is an eminently serious disease to the victim, but it is no longer necessary or expedient for troops to decamp when its accidental presence is discovered. Neither the person, the quarters, nor the effects of the sick play any part, as such, in its propagation. It develops in man within five days after infection. Non-immunes who do not sicken within five days after exposure may safely be released. That rule governs the quarantine of persons. The quarantine of property is governed by the fact that it requires not less than twelve days from the time it was infected for the *stegomyia* to become capable of transmitting the disease. Consequently during this period the most vigorous war must be carried on upon all possibly infected mosquitoes, through fumigation directed against all manner of containers where the sick person has been, whether in an ordinary habitation or aboard ship. This must include everything movable, from hand-bags and blanket-rolls to railroad cars and sea-going vessels. All recesses must be thoroughly explored. Disinfection by germicides is superfluous, but the destruction of the mosquito is imperative. In the general campaign against the

Prevention

Havana and the Canal Zone

Elimination of mosquitoes

Quarantine of persons

Quarantine of property

Extermination of mosquitoes

stegomyia the rules already explained in connection with the *anopheles* are to be followed in relation to both the larvæ and the adult. With the opening of the Isthmian Canal and the conduct of direct trade through the tropics, the utmost care must be observed not to admit infected insects aboard from American coasts and convey them to the Pacific islands and the shores of Asia, where the disease has never appeared. The uninfected *stegomyia* abounds in the Philippines, and we should take unremitting pains to withhold that fatal gift. The probable explanation of the revival of yellow fever on vessels with clean bills of health but previously infected, while yet at sea as they approached warmer latitudes after spending the winter in cold harbors in the hope of freezing out the disease-cause, is that the infected insects hibernated in the recesses of the ships. On sea or land yellow fever ceases abruptly with the occurrence of frost, but on shipboard the approach of cold may be gradual and it is possible that the mosquito may escape death by making its way to a suitable retreat. The writer knows of no reported instance of the hibernation on land of infected mosquitoes.

Danger to Asia

Hibernation on shipboard

The older method of escaping yellow fever when it appears in a community, by removing the troops to a point where the disease will not spread, usually to be found not remote from the seat of the outbreak, is rarely necessary now that the mode of propagation is understood. It depended upon leaving behind the domiciliary *stegomyia* and either reaching a point where that mosquito was not present or where by great good fortune the fugitives did not infect it. This course may still very properly be pursued if a garrison is in immediate proximity to an infected civil community incapable of dealing with the situation. A relatively short transfer usually suffices. Pending the Cuban operations of 1898, certain volunteer regiments raised in the South were styled Immunes. This official designation had absolutely no foundation in fact and therefore

Avoidance of yellow fever

Immune regiments

was false and misleading. There is no natural immunity against the malarial fevers, and immunity against yellow fever, which was here implied, is only acquired by passing through the disease. To call a person or a command not thus immunized immune, imposes upon the credulity of an uninformed constituency.

XXX

PREVENTABLE DISEASES; TYPHOID FEVER

Typhoid fever

Typhoid (more properly enteric) fever is one of the most serious scourges that afflict an army, and it has heretofore been regarded by most commanding officers as something to be endured because beyond control. Born of ignorance this was also the older view of scurvy, plague, cholera, and, in civil communities almost to this hour, of tuberculosis. There is no reason why typhoid fever should not become as exceptional as smallpox, if officers in command appreciate their opportunities and intelligently exercise their authority. But that will not happen under generals whose inner consciousness leads them to rehabilitate condemned wells, or by untrained colonels who publicly pronounce worthy of death soldiers willing to undertake the onerous and frequently hazardous duties of sanitation and relief for the sake of comrades who may never hear a hostile shot.

Sagacious control

Statistics

According to statistics used by Major F. F. Russell * the Federal Army alone had more than 80,000 cases of typhoid fever in the War for the Union; the Germans in the Franco-Prussian war had more than 73,000 cases and nearly 9,000 deaths; the British in South Africa had 31,000 cases and nearly 6,000 deaths. During five months in the Spanish War † we had 20,738 cases and 1,580 deaths among 107,973 officers and men in camps within the United States; or 19.26 per cent. suffered from this disease. Very nearly all of these were secondary cases; that is, they spread after enlistment from exotic cases that arose before regimental or concentration camps were

Source

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* *Military Surgeon, June,* 1909.

† *Official Board on Typhoid Fever.*

established. Occasionally they were derived from contaminated centres which had been overlooked and thus became disseminating foci. As a nearly absolute rule, all these cases represent as many individuals. As a typhoid case is rarely fit for duty within three months, many not for a longer period, and as some who do not die must be discharged for disability, it appears at what fearful cost these ravages are permitted. Any soldier can compare such useless sacrifices with the casualties of battle. With the best treatment hitherto available, the actual mortality in civil practice is six per cent. of the cases, while under the disadvantages of the field it must rise higher. The rate in camps in the United States just referred to was 7.62 per cent. of the cases, or 14.66 per 1,000 of mean strength. In addition to the loss of physical vigor directly due to so many deaths and so much illness, there are further to be reckoned the enormous drain upon the labor and pecuniary resources of the army, the inevitable depression when a single disease disables for a prolonged period one man in five, and the restraint that such widespread and serious incapacity imposes upon military activity. In the first period of a war typhoid fever is a more serious enemy to newly raised troops than the foe in arms, and, paradoxically, they escape its ravages only by having suffered them; for, like other diseases of its generic class, typhoid fever very rarely attacks the same person a second time. Until the disease, endemic the country over, is obliterated, accidental original cases will unavoidably bring primary cases to such regiments; but every secondary case is a reflection upon the sanitary administration or the military discipline of the command, or upon both. Commanding officers of companies, of regiments, or of greater commands, cannot remain content with seeing sent to hospital men who should never have been infected. It is their duty to appreciate the methods of infection and to inhibit them.

Prolonged disability

Mortality

Drain upon vigor

Typhoid among new troops

The specific cause of typhoid fever is a bacillus, microscopic as all bacilli are, bred from earlier bacilli of the same kind [*] and discharged in vast numbers always from the intestines and in many cases very copiously with the urine of the sick. Should these pollute the drinking-water, the infection would at once be evident because it would be general, so that cases would appear all along the line. When single cases are found here and there, the water probably is not at fault. The evidence of general water contamination is usually moral rather than physical, and it is so nearly impossible to identify the bacillus that it is useless to require microscopical proof to establish the charge. In peace the water-supply commonly is above suspicion, although sometimes the standard is maintained only by vigilant inspection. In the field, in inhabited regions, because the water may be contaminated at any point, stringent filtration or recent sterilization is imperative. Although sterilization by heat is certainly trustworthy, and it has generally been held that there is no chemical method of antagonizing the typhoid poison so as to make the water fit to drink, Notter and Firth [†] are of opinion that a tabloid of two grammes of 70 per cent. sodium bisulphate sweetened with saccharin and flavored with oil of lemon to make it palatable, will sterilize one and three-fourths pints of water in twenty minutes. The water is not made unpleasant, but tastes somewhat like lemonade. If this is effective on a large scale in quantity and retains its quality for a prolonged period, as there is no reason to doubt, the distinguished designers have accomplished a very beneficent work.[‡] As

Cause

General water contamination

Sterilization

Sodium tablets

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[*] There would be plausible grounds for supposing that an innocent habitual intestinal bacillus *may* acquire this specific virulence, did not all expert bacteriologists deny that possibility.

[†] *Hygiene*, 3d ed., p. 931.

[‡] It is claimed to be equally effective against the cholera and dysentery bacilli.

they remark, it should be specially serviceable for mounted men. In camps non-alcoholic drinks, including bottled commercial waters * vended by dealers, sometimes may be direct sources of this infection, and these should be supervised or prohibited outright. A Sanitary Provost Marshal for the control of hucksters in camps, if they are permitted there, and for the supervision of dealers beyond the lines (which would require legislation in the absence of martial law), should be a useful official; or the exercise of such peremptory authority may be appropriately added to the duties of a Sanitary Inspector.

Supervision of beverages

Typhoid fever is contracted only by swallowing the bacillus which, under military conditions, is disseminated, apart from the occasional agency of water, by contact, by dust, and by flies. The minuteness and the profusion of bacteria are difficult to realize. Because invisible, one is tempted to think of these lowly organisms in any particular situation as non-existent. If we associate the persistence of an odor once attached to a textile fabric as due to a particulate base in which the odor resides, by comparison we may appreciate how bacteria cling to transmitting agents. The person of the patient (not as derived from the skin itself or the perspiration), especially his hands and the hands of his attendants, may harbor myriads of these germs diffused from the grosser excretions. So with utensils used by the sick. So with the soil near which they may lie in camp hospitals and especially while yet in their tents. Equally so with underclothing, and frequently in badly policed camps with the shoes. The greater risk occurs when these articles are inappreciably polluted before the disease has been recognized. Havard † cites a striking instance where the infection was carried from Minnesota to Cuba in the company baggage. One of the most vicious practices, always to be discouraged,

How contracted

Minuteness of bacteria

Contact, primary and secondary

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* *Abstract Official Report on Typhoid Fever*, pp. 209, 210.

† *Military Hygiene*, p. 20.

is that of covering way-side discharges by scraping the soil over them with the shoe or with some article of personal equipment. Should the discharges be infected, the implement runs great risk of infection also. They should be covered, but by an object to be destroyed or abandoned. Clothing, blankets, tentage, once polluted are protracted sources of danger. The source of a camp epidemic has been traced tent by tent to this agency of contact,* unwitting but real. Successive, not simultaneous, cases in a family usually depend upon contact. As a rule exemption from the disease by a company (there being no general infection) is in direct proportion to the neatness which good discipline maintains. The province of line officers here is to enforce the advice the medical officers give. Cleanliness of the person, of the tent, of the street, and the strictest police of the sinks are to be maintained, all according to the camp régime already indicated. Men should be required habitually to wash the hands carefully before taking food. Frequently that is impossible in the fiold, but the habit established in garrison promotes its observance elsewhere and lessens the risk of contact infection. The camp streets should be kept dry and free from dust, but not by dispersing dust-clouds over every place outside the streets. In camps of position these are best oiled. Blankets suspected of being infected should never be packed away without disinfection, for they may retain the germ in a communicable state for very long periods; and as a precautionary measure all company and personal property used by recognized typhoid patients shortly before admission to hospital should be sterilized. Experience warrants formal disinfection of a squad-room and its contents when repeated cases have occurred in it, other rooms being exempt or no external cause being detected. This because general contamination of the residual dust of the apartment is then probable. In foreign services such action has been followed by the prompt

Precautions

Disinfection of squad-rooms

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* *Abstract Official Report on Typhoid Fever*, pp. 113 *et seq.*

cessation of local epidemics. This is not to be misunderstood as teaching that the patient himself is a source of contagion, in the sense that a scarlet fever or a measles case would be. Typhoid fever spreads solely through the alvine and the urinary discharges and there is no danger from the personal presence of such a patient, extreme cleanliness concerning those discharges being observed. But mild and unrecognized cases may be detained in quarters long enough to infect them unawares. In ill-kept camps this is a common condition, and the dust becomes so charged with these vicious bacilli that relief is found only in complete removal to a clean site beyond the influence of the former, and the simultaneous disinfection of all clothing, bedding, and tentage. Living typhoid bacilli have been found in blowing dust after twenty-five days.*

Typhoid not contagious in the common sense

Infection through mild cases

Flies, like mosquitoes, have been accepted so long as an annoying but harmless institution of nature that only in late years has their agency as disease-bearers been seriously considered. They were regarded as serviceable consumers of organic waste, not as carriers of decomposing filth. The domestic fly does not directly infect man, although there are varieties which introduce parasites into his blood; but it is an industrious and effective carrier of typhoid and other bacilli. Flies infest collections of human waste, and sometimes the bacilli taken up in their quest for food are discharged with their own excrement where they alight. But more commonly they bear entangled upon their feet filth, charged or not with specific bacteria as it may chance, with which they mark their trail. Such journeys from sinks and cesspools to kitchens, to dishes of prepared food, to table furniture, have been repeatedly and unmistakably demonstrated. When the sinks themselves are infected, this direct and vicious aërial route becomes a literal highway of disease; and in camps where the water is good, flies may be infection-

Functions of flies

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* Firth and Horrocks, *British Med. Journal,* 1902, vol. 92, p. 936.

Precautions against flies

Breeding-places

Formalin to kill flies

Manure

bearers of the first rank. Where not restrained, particularly in encampments, they are prodigal dispensers of filth and its associated evils. A double duty therefore presses for attention: the sterilization of cesspools and other sinks, and the precautionary screening as far as possible of kitchens, food, and mess-tables. By preference the house-fly, which is very prolific, breeds in horse-manure, but its eggs are also laid on other decaying material, including the contents of kitchen and company sinks. The period of generation ranges from ten to fifteen days, according to the season and the latitude. A profusion of flies is a sign of much débris; conversely, their scarcity indicates sanitary cleanliness. The most efficient exterminator of the fly within doors is a five per cent. solution of formalin in sugar water. Flies drink this greedily and die promptly. Manure piles should not be tolerated within or near a camp or garrison, excepting under urgent necessity, for there is no recognized destroyer of these breeding-places which may be used on a large scale.

Restraints of discipline

Specific discharges during incubation

Certain conditions in the dissemination of typhoid fever directly concern company, field and general officers as maintainers of discipline. As experience shows it impossible to concentrate any considerable number of recruits or to bring into camp even one new regiment without the disease appearing, and as the cases multiply in direct proportion to the number of those groups, it is essential that from the moment camp is opened the use of the sinks be compulsory. Rude and thoughtless men when uncontrolled relieve themselves anywhere beyond observation; and example encourages repetition, so that ill-disciplined camps have been encircled with that forbidding barrier. This barbarism is to be suppressed, not merely for decency's sake but because it is impossible to distinguish between evacuations that are merely disgusting and those that are infected;

for it is certain that sooner or later the disease will be represented. As a rule the incubation of typhoid fever occupies about ten days, but the specific bacteria are discharged from the first and usually this incubation is accompanied by a looseness of the bowels which multiplies the chance of contamination. Occasionally a severe dose of the poison excites such irritation that the whole is expelled by a brief but sharp diarrhœa before absorption, and those discharges also spread the disease while the original subject escapes the fever. Further, there are so-called "walking cases," which by reason of their mildness and of inaccurate diagnosis escape recognition and isolation and remain ambulant distributers. Most dangerous of all is the typhoid "carrier," to be noted later. The company officer properly repudiates direct responsibility for the disposition of the sick, but under none of these conditions are the unsound men segregated for medical control. Both classes, the merely filthy and the infectious, are outwardly indistinguishable, excepting that advancing disability leads more urgently to indiscriminate personal relief. All these offensive centres resemble the contact mines sometimes planted in a field of prospective assault, of which a certain indeterminate proportion explode when least expected. If they are not sown broadcast, the margin of safety is greatly widened. It is the direct duty of the officers of the line in whose hands is the machinery of control, to maintain the whole territory of occupation as unpolluted as a parade ground. Nor is it sufficient merely to enforce an invariable use of the authorized sinks. As just shown, these frequently would then receive a proportion of infected dejecta. Consequently their entire contents should be unremittingly sterilized, further to diminish the risk of general infection through flies and dust.

Infective diarrhœa without illness

Walking cases

Danger areas

Duty of the line

Disinfection of sinks

Unreasonable proximity of neighboring commands and their conveniences, and unwarrantable compression of regimental camps are important contributing causes to the spread of this commonest of field diseases, besides inflicting unnecessary discomfort and the risk of other illness. Company officers cannot be held responsible for such errors, for camp sites and camp residence are determined by higher authority. It is of record * that in the great Chickamauga encampment of 1898, regiments were so near each other as to receive washings from foreign sinks on higher ground and, in at least one case, the company sinks were within thirty yards of the kitchens with the kitchen sinks between the two. Notwithstanding repeated requests for relief, some commands were retained for nearly three summer months on identical ground, and in others tents were not shifted for a similar period. "In some instances the tents of the same company were so close together as to leave no space between them, and those of two adjacent companies were crowded together back to back.' † Translated into plain English this means sheer ignorance, not intentional manslaughter. But unless brigade and division commanders and their inspectors acquire the rudiments of sanitation, history will repeat itself in the next war with the same dolorous consequences and domestic disease will be far more deadly than foreign bullets. Under our system of administration, it is not the Medical Department, it is the Line of the army that leads its men to these rendezvous of death.

Proximity Immobility Overcrowding

Besides more obvious modes of infection, line officers should understand two possibilities, whose occurrence is rare but which may have to be considered in the investigation of an outbreak and, in one of the instances, in the disposition of an intermediary. One is that an immune individual may receive typhoid bacilli at a distant water-supply or otherwise, may carry them to his own neighborhood where, through an otherwise normal evacuation, he

Infection through the immune

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* *Abstract of Official Report on Typhoid Fever in the Spanish War*, pp. 52, 53, 180.

† *Op. cit.*, p. 187.

may deposit them so as to infect the local water-supply and occasion an epidemic.* This requires an extraordinary combination of incidents, but it is possible. The other is the occasional persistence of these bacilli in the body of a recovered patient and their discharge for indefinite periods in otherwise normal fæces and perhaps in the urine. Such persons are known as "typhoid carriers," are themselves unconscious of their unfortunate endowment, and are a constant menace to the health of the community. A "carrier" is a medium for the cultivation of a germ to whose influence he has become immune but which he constantly distributes. One such civil case is recorded where in the course of several years twenty-eight distinct infections followed the progress of the carrier. It has been estimated that in Europe about three per cent. of recovered cases are carriers for longer or shorter periods. There are no available American statistics. No such agent of morbidity can be tolerated in the military service, and consequently every convalescent from this disease must be isolated so far as his dejecta are concerned, until bacteriological examination establishes his typhoid sterility. When such a case is found his disposition becomes a serious problem, which does not require solution here further than to say that he should not be retained in the ranks or in other intimate connection with the soldiery.

Typhoid carriers

The typhoid germ may survive outside the human body for long periods, as on a folded woollen cloth for eighty days and in otherwise polluted soil for practically indefinite periods. Upon these facts rest the requirements that company commanders should present for disinfection the blankets of their typhoid men before storing them away or otherwise disposing of them, and the positive prohibition against occupying sites previously encamped upon at even a remote date. The exception is for camps of position conducted

Viability of the typhoid bacillus

Old camps

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* *Abstract of Report on Typhoid Fever*, p. 203.

under strictly sanitary conditions and known not to have harbored this or other diseases. The viability of the bacilli of non-disinfected discharges in the earth is so vexed and unsettled that it is safer to bury them deeply, notwithstanding the active bacteria supposed to neutralize them in otherwise unpolluted soil reside in the upper layers. When thus buried, the proximity of a water-supply should be avoided.

Burial of typhoid discharges

It is believed that about 60 per cent. of civilians of military age are non-immune to typhoid fever, so that in view of its constant presence among raw troops, the gravity of the disease, and the restraint it imposes upon military operations, it is of enormously greater importance to prevent the infection of the well than to cure the sick. Such prevention seems practicable at a certain although slight risk, by inducing artificial immunization through inoculation with prepared typhoid cultures, and this has been practised within a narrow range. To call this process "vaccination," a term seeking introduction, is more than ambiguous, it is a misuse of English. "Vaccination" implies connection, directly or in the past, with a bovine agent, and by long-established usage describes a form of protection against small pox, which has nothing in common with typhoid fever. It is impossible to "vaccinate" against this disease, for cows neither contract it nor furnish a preventive; and the word in itself implies neither prevention nor infection, except in a very secondary sense. The practical objection, beyond its defilement of the language, is the confusion it is liable to create in the minds of the laity. "Anti-typhoid inoculation," although cumbrous, is truthful and expressive, and until a technical designation is coined may best be employed. In the British service this inoculation is contingent upon the consent of the soldier. Notter and Firth* make this report of the experience of the 17th Lancers in India, in 1905, when attacked

Preventive inoculation

"Vaccination" an inapt term

Anti-typhoid inoculation

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* *Hygiene*, 3d ed., p. 676.

by the fever: "Of 514 persons in the regiment, 127 submitted to a complete inoculation against enteric by means of two injections, 23 received only one injection, and 364 refused to be inoculated at all. No cases of enteric fever occurred amongst the 127 cases fully inoculated, 2 cases occurred among the 23 partially protected, and 61 cases occurred among those who refused to be inoculated. It would be difficult to find a more striking series of figures." Such protection is not yet permanent, but it is presumed to last at least two years, and even when the disease occurs the case-mortality is reduced to nearly one-third. On the occurrence of war, this preventive use of the typhoid culture should be obligatory with all soldiers non-immune through not having had the disease or by recent inoculation. In peace it may properly be optional until experience makes its value a part of the common knowledge and custom of the times.

Compulsion in war

XXXI

PREVENTABLE, COMMUNICABLE, AND AVOIDABLE DISEASES, AND DISINFECTANTS

Cholera

Modes of infection

Cholera bacilli in the soil

Old camps

Disinfection

Cholera, an occasional epidemic of great violence in temperate climates and a frequent pestilence in the Asian tropics, is propagated by the discharges from the stomach and bowels and not otherwise. Unlike typhoid fever, it may recur again and again in the same person, and like typhoid fever it most frequently begins with a painless diarrhœa, which it is important should not escape upon the ground. In all cases the infection enters the mouth. The commonest general agency is a specifically polluted water-supply, whether from a well, a reservoir, or directly from a river; but besides, indirect contact-cases are frequent, especially in camps where the shoes and other clothing may be soiled by the watery excreta. As with typhoid fever, flies industriously disseminate its active bacteria. When it is influenced only by natural conditions, the cholera cause probably escapes change in the soil for a considerable period; hence it is an axiom of military sanitation that an old cholera camp may never be re-occupied. From the soil it is quite possible for the bacillus to become attached to and to taint by its presence the fruit and vegetables grown directly thereupon. Consequently, where it prevails uncooked food is very liable to infection through careless handling. The bacillus appears to have a relatively short life in water, except as it is continuously reënforced from without. But the testimony is conflicting, and it is safer to sterilize all water of which there has been the least suspicion. The disinfection of all discharges and of all articles contaminated by them is imperative, and this is rendered difficult because of their appearance, of their volume, and of the force with which frequently they are ejected.

Infected clothing

Choleraic discharges are copious and colorless, so closely resembling rice-water as to have acquired that name as descriptive. Clothing and bedding are frequently saturated with them, and uncleanly persons, as immigrants, because they are not seriously stained, often transport them unwashed, and the disease reappears when they are again brought into use. In 1848 certain emigrants from Europe went to New Orleans in a sailing ship. As it happened, while on shipboard and several weeks out of port cholera broke out among them, and it was supposed that the vessel had entered a cholera cloud, which consisted with the current view of aërial infection. In fact, the temperature having changed, certain boxes of clothing had been opened for use and these, contaminated before packing, infected those who handled them. The pursuit of our troops by cholera in the Black Hawk war was undoubtedly through not dissimilar contact. No bedding, clothing, or other material liable to have been infected should escape vigorous disinfection, preferably by fire, and it would be criminal to retain any such property in store or to put it to other use untreated.

Acids antagonize cholera

Acidulated beverages

It is probable that the cholera poison does not flourish in acid fluids, either within or without the body, and that it spreads more easily where alkaline fermentation occurs. Hence to acidulate the discharges is one of the best preventives. This applies to typhoid fever as well. The discharges should be disinfected whether they pass into sewers, into sinks, are buried, or are consumed; and they should be placed beyond any possible risk of contaminating the upper soil or the water. Munson quotes Christmas as saying that 0.6–0.8 gramme citric or tartaric acid to the litre (5–7 grains to the pint) surely sterilizes water against the cholera cause. This is perfectly harmless and is not disagreeable. The sodium bisulphate tablet (*ante*) is also a plausible remedy. In an outbreak of cholera, in the absence of direct medical advice it would be well, besides boiling the water, to require the command to use an acidulated drink, such as an aromatic sulphuric acid "lemonade." It is believed that this preventive treatment has saved special communities from the disease. To that end this acid should be a part of the detachment supplies in cholera countries, where a medical officer may not be accessible. Because it is possible that digestive derangements facilitate the morbid action of the cholera bacillus, there should be special avoidance of all diarrhœal or gastric irregularities in cholera seasons or places. The precautions against contamination through "walking cases" and by flies, advised in the case of typhoid fever (*ante*), apply here with equal force. Where cholera prevails, alcoholics and those exhausted by excesses or physical fatigue are the least liable to escape illness, the bacillus once taken into the body; for, as with typhoid fever, it is probable that in some instances the infection passes off without seriously affecting the system, but that is not the case with the dissipated and broken down. Preventive inoculation against cholera is available. It seems to reduce the number of cases to less than one-tenth of those among the non-inoculated equally exposed; but it should not be substituted for scientific sanitation. Its efficiency endures for a little more than a year.

Predisposition

Flies

Dissipation

Inoculation against cholera

Tuberculosis in the form of consumption is one of the most prevalent diseases of civil life and, notwithstanding the care taken in recruiting, men in the ranks are constantly discovered to be tuberculous. This is probably due to a latent infection which showed no physical sign at enlistment. Its evolution may be due to military conditions, and it would be an interesting story to determine what similar factors, if any, of quarters, nutrition, duty, or exposure oper-

Consumption

ated in groups of recruits who became consumptive. It is eminently infectious where the air-space is insufficient, and from this cause garrisons, especially in foreign armies, were formerly ravaged by it. Because of the greater attention paid to preventive medicine, and especially because of the increased allowance of air, the military case-rate and the death-rate alike are diminishing. But it requires vigilance to maintain the conditions for health. In proportion as an occupied apartment is crowded, is there risk of the spread of this disease from a case accidentally introduced, or from the development of one heretofore latent. This risk diminishes exactly as the air-space enlarges. Consumption depends upon a bacillus disseminated not by the breath but by the expectoration which is charged with it. When the sputa are sufficiently dried to be blown about, in the barracks or in camp, they may be inhaled and the contained bacilli, if they escape destruction in the blood, as happily the most do not, set up the disease. It is true that such high authority as Notter and Firth,* following Flügge, are of opinion "that the theory of infection following inhalation rests upon imperfect knowledge," but it is certainly a safer theory to follow in garrison. For it is very difficult to confine the explanation of that direct increase of this disease which is recognized to accompany overcrowding to the effect of impure air in the chemical sense, and to dissociate therefrom the pathological contamination which the sick are known constantly to disseminate.

Relation of cubic space

Cause of consumption

Inhalation theory

As soon as the sputum (the phlegm) in any protracted "cold" becomes yellow, which is a sign that it is purulent, it should be examined microscopically for the bacillus and, when that is certainly found, the soldier should be transferred, without further delay, to the sanatorium provided for such cases. Company officers should be vigilant to require men with persistent coughs not already on sick

Early attention

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* *Hygiene*, 3d ed., p. 725.

report, to report, however unwilling they may be to do so, for medical examination, in justice to themselves and to their comrades; for the actual expectoration and their explosive coughs and sneezings may infect bedding, barracks, and other men. Disinfection of material and apartment should promptly follow the recognition of tuberculosis. Notwithstanding consumptives may be successfully treated at many of the military posts, such men should not be retained with their companies, but be segregated at the designated station. After entering the post hospital, preparatory to transfer to the general hospital, the man passes directly under professional care, which is beyond the purview of this work. It is important to remember that consumption progresses so rapidly at the humid sea level in the Philippines, that immediately upon its bacteriological recognition, or when the physical signs are clear, removal to the interior high table-land, or, better, transfer to the United States, is imperative.

Disinfection

Tuberculosis general hospital

In the Philippines

Diphtheria is an eminently infectious disease which has no peculiar relation to military life, but whose introduction into either barracks or quarters should be the signal for a vigorous campaign of prevention among those who have been exposed to it, and for the destruction of the contagium where it might have found lodgment. Diphtheria depends upon a bacillus, which enters the air-passages with minute particles of false membrane dislodged by coughing or sneezing. Although imperfect ventilation fosters the spread of diphtheria, this is not due to the simple inhalation of the breath of the sick; but contact of a mucous membrane with the specific cause is required. Such contact may be through infected utensils, clothing, and in so many unforeseen ways that an apartment and its furniture which have harbored diphtheria should be radically disinfected, notwithstanding ordinary cleanliness may have been observed during the illness. The infection once established

Diphtheria

Disinfection

clings persistently, sometimes for months and even years. Milk from diseased cows, independently of its human infection, may induce diphtheria; hence inspection and, if necessary, restrictive control of the milk-supply should be exercised by the commanding officer where diphtheria, not otherwise accounted for, enters a garrison. The domestic cat is susceptible to the disease and is a good carrier of it even when not itself ill; which should exclude these pets from contaminated married quarters. A protective anti-toxin, administered subcutaneously to healthy persons exposed to diphtheria, will immunize them against it for a limited period, and is useful in thus strangling an epidemic. As with some other infections, occasional recovered cases may as carriers retain the specific bacilli for considerable periods. Such men, although apparently fit for duty, must be detained from quarters on probation.

Milk

Cats

Anti-toxin

Carriers

Small-pox has been so shorn of its power by protective vaccination that some, not familiar with social history, are disposed to look upon it as practically extinct, or as of little gravity when compared to the imaginary perils with which they endow that most innocent and far-reaching preventive agency. When uncontrolled, small-pox is a loathsome, comprehensive, and very fatal plague, disfiguring and crippling many who escape death. Vaccination, which insures practical immunity against small-pox for a number of years, should be carefully but not too frequently performed, preferably by quadruple insertions in one of the extremities. Thorough vaccination in infancy, repeated at the age of 14–16, generally protects throughout the military age; but every recruit should be presented for examination, and preferably for trial vaccination, when he reaches a proper station. The general vaccination liable to be ordered whenever the proximity of small-pox is reported is unnecessary if the command is already immune, and this should be determined by the medical

Small-pox

Vaccination

officers. Protected persons need avoid those infected only lest their clothing may bear the highly active infection from the sick man to others unprotected, representing a mediate form of infection. They themselves will be safe. The exclusion of small-pox from a post is coördinate with the degree of authority exerted over the heterogeneous women, children and employés comprehensively grouped as camp-followers. If the commanding officer requires their habitual enrolment, stated inspection, and vaccination when necessary, protection may be assured. If there is no record and no order they remain an insanitary mob.

Camp-followers

Varioloid is modified small-pox, not a distinct disease, of passing importance to the individual, but capable of communicating true small-pox to others. The isolation required in small-pox applies also to varioloid. It sometimes happens that small-pox occurs in an unprotected and isolated detachment where vaccine virus cannot be procured. It then becomes the duty of a competent person to perform inoculation, better called variolation, which induces true small-pox, but usually of a mild type. Where there has been small-pox, for all property that is combustible fire is the most trustworthy disinfectant.

Varioloid

Inoculation or variolation

Measles is a highly contagious disease, as yet preventable only by good fortune in evading its presence, which, sooner or later, becomes impossible. Recruits from populous districts are usually immune to it because of having contracted it in childhood, but that is not the case with those from the country. It is a serious disease for adults, especially under the exposure of the camp and in cold weather; and it is always to be anticipated in newly raised commands as certain to include those from the rural districts. On account of its prevalence and the gravity of its complications there should be special hospital provision for it with new levies, and commanding officers must make allowance for it as diminishing the mobility and the efficiency

Measles

of the troops in the earlier stages of a war. In 1861–5, there were 67,700 cases with 4,200 deaths among white troops in the Union army, and after colored troops were organized they had 8,555 cases and 933 deaths. Among the Confederate forces, not only regiments but brigades were temporarily disbanded on this account in the autumn of 1861.

Mumps

Mumps, also contagious but less so than measles, not so grave as that disease but serious in its complications when under canvas, is also to be reckoned with as inevitable among new troops, and especially in those from the country, in an epidemic form. There is no known preventive.

Scarlet fever

Scarlet fever is not an inevitable disease, but it is very serious under climatic exposure, especially in northern latitudes. The direct contagion of this fever is not strong, but its persistence is extreme, surviving for years and even after prolonged burial. Everything connected with such a case in a household, toys, clothing, and especially books, should be burned. Small wooden houses thus tainted about a post it is safer to destroy by fire, and infected tentage also should be burned. More permanent apartments are to be thoroughly scraped, scrubbed with corrosive sublimate 1 to 1,000, and lime-washed or painted, as the case may be.

Dysentery

There are several forms of dysentery, an entirely distinct disease from diarrhœa, with which it is confused in some not well-informed minds. The most serious of these are tropical complaints, not only dangerous to life but obstinate in their course, resistant to treatment and very liable to recur. Like typhoid fever these may be caused by contaminated water and by contact, including contagion through flies. Flies may carry the infection to food, and sometimes they directly infect the well at the very sinks. These bowel troubles, sometimes causing immediate incapacity, at other times permeating the command at large, so that its fighting ability recedes and advances under their influence as the tide of disability runs higher or is diminished, may deprive the general of a large section of his effective force in the hour of need, and certainly impose a train of invalidity that distresses the victims for the remainder of their lives.

Prevention

The prevention of dysentery in the tropics follows with no intermission the same lines as those against typhoid fever in the presence of an epidemic. For the invisible seeds are always at hand, awaiting opportunity for growth in human soil. The very careful washing of all fruit and vegetables eaten raw, and the certain cooking of all other food, are even more important than with typhoid fever, because possible infection is so wide-spread. This necessity must be constantly explained and the orders be enforced.

Beri-beri

Beri-beri is a grave disease, practically although not literally confined to the rice-eating inhabitants of tropical and subtropical countries, which shows itself in two forms. Without discussing its pathology, it is sufficient to say that, while beri-beri is believed to originate through errors of diet, places seem to become infected. Americans are unlikely to be concerned with this disease excepting in the way of Philippine administration, and officers in authority should exert their power to lessen a morbidity that is distressing and a mortality sometimes appalling when such responsibility is not recognized and the hand that might help is withheld. In general terms the sick and their associates (for usually there is a group, sometimes a large number) should be transferred to another and a dry situation, the dietary should be enlarged, and the rice furnished in it should be the brown cured variety, that has been boiled before husking and storing. The gravity to the dependent nations of beri-beri, which is not a self-limited disease, should never be forgotten by the officer in control.

Leprosy

Leprosy is another disease generally, but by no means exclusively, confined to Asiatics, and is particularly rife in Hawaii. It probably spreads through accidental inoculation by an infected object, as a fish-hook, a contaminated splinter, or some unsterilized article of table furniture conveying the bacillus under the skin or to a preexisting ulcer. Leprosy is presumably not contagious in the common sense, and there is little need to isolate lepers as long as they are not offensive to the eye, excepting as they are liable to infect utensils or other objects of common use, or to distribute the bacillus out of the body with dangerous frequency. Soldiers should be cautioned to avoid the habitations and the haunts of lepers for fear of accidental inoculation, and when it or plague prevails all abrasions should be sealed.

Plague

Plague, more widely spread than beri-beri or leprosy, is not confined to the brown and yellow races among which it is most common; but without great care it may ravage the world, as in earlier times it desolated Europe. Under our flag it is practically confined to the oriental races, but it is always a menace to our troops in the Philippines. The plague is primarily a disease of the rat, and in man is due to accidental inoculation with a specific bacillus (*b. pestis*) which is communicated by the flea (*pulex cheopis*) that is harbored by the animal. The common flea (*p. irritans*) is not a plague-bearer. Plague is probably perennially endemic in rats, and it has been observed that an outbreak of an epidemic in man is apt to be preceded by a fatal epizoötic among the rats of the region. When large numbers of the rats die, it may be that the fleas turn to man as to a required new feeding-ground. Rats and rat-fleas particularly infest the unclean habitations of many Asiatics, where the exposed extremities of the natives invite attack by the parasites. It has been alleged that the smaller black house-rat is the natural host of this flea and that as it has been replaced in Europe by the larger brown rat the plague has gone with it. Prevention requires the killing of the rats that harbor the disease-bearers and drenching the dead animals while still *in situ* with a wash that will destroy

Rat

Flea

Black rat

the flea. Campaigns of this sort require intelligence, ingenuity, and boundless energy, to be successful. Cleanliness of the person and of his environment is an important element of protection. In the presence of an epidemic, inoculation with an anti-toxin devised by Haffkine yields excellent preventive as well as curative results. Although this flea belongs directly to the rat, it may infect native clothing and bedding, and therefore the habitations and personal effects of the infected, as well as those that accompany all emigrants from such districts, should be disinfected. The military relation of plague lies in the necessity for preserving garrisoned posts and the troops at large free from infection, and in the obligation of the official American to advance sanitation in the insular possessions.

Prevention

Preventive inoculation

Distinctly parasitic diseases of men and animals, as for example the uncinariasis of Porto Rico (and perhaps of our Southern states) and the surra of the Philippines, invite attention as within the philosophical bounds of military hygiene, but their consideration is omitted as beyond the conventional limits of the subject.

Uncinariasis and surra

Venereal diseases are preventable only in the sense that they are avoidable. With insignificant exceptions they are due to direct contact with infected tissues. The only way to avoid the disease is to avoid the risk, and this resistance to man's strongest primitive instinct, upon which depends the perpetuation of the race, involves a moral power and physical control which few celibates compass. Legitimate amusement and abundant occupation within the garrison, and plain instruction as to the perils involved in vicious indulgence, are the most hopeful means of limiting this evil. Men with these affections in an acute form should be eliminated by inspection from every expeditionary command, and the loathsomeness of constitutional syphilis, with the constant risk of secondary infection from it attending certain stages, warrant its subject to be dis-

Venereal diseases

charged without honor instead of devoting the period of a short enlistment to its attempted cure.

Disinfectants

"A disinfectant is an agent capable of destroying the infective power of infectious material;" and substances that merely neutralize bad odors are deodorants, not disinfectants. Those which simply mask one form of offensive smell by another may be neither. Fire, direct sunlight, dry heat, steam, boiling water, dry earth, sulphur in combustion, chlorine, lime as a chlorinated compound, quick-lime, corrosive sublimate, derivatives of carbolic acid, and formaldehyde and formalin are the most serviceable under military conditions.

Fire

Fire, as its kindred word, pure, makes plainer, is the primitive, and also when properly used the most effectual, cleansing agent. It abolishes with no hurtful residuum every infective agent to which it can be applied. Its general use is limited only by the necessary destruction of most of the infected substances when it eradicates the pernicious accidents which bestow upon them their mischievous character. The first impulse is to regard burning as wasteful, but often it is true ultimate economy utterly to destroy property that otherwise may be a continuing source of disease and disability. Fire also renders a subsidiary but useful service in consuming the fragments of food and perishable material left in cans and other receptacles when ready to be thrown away; and with some care the remnants from the mess-table that otherwise would become garbage may be immediately desiccated if not consumed.

Sunlight

It is to the action of sunlight in devitalizing fugitive bacteria blown about with the dust, the dried sputa and other excreta, or that rest in accessible cracks and crevices, that garrisons and camps as well as civil communities owe much of their exemption from possible disease. On the other hand dark habitations are liable also to be damp and unwholesome, as casemates. For this reason, with others, camps should not lie in the jungle or dense woods, and barracks should be arranged for flooding with direct sunlight a part of the day. Constant exposure to a brilliant sun in combination with heat, as in the tropics, is harmful to human health, but man profits in the end by its limitation of bacterial life.

Dry heat, steam, boiling water

Dry heat and steam, the latter generally under pressure, are used with special sterilizing apparatus in the hands of trained men. They are a part of the appliances of large hospitals, and as such do not concern us here. Boiling water is the most convenient agent for applying bactericidal heat to adaptable articles. Speaking generally, these are cotton and linen fabrics and most utensils.

Dry earth

The ordinary mould of superficial soil is very rich in nitrifying bacteria. It is upon this quality that the value of the earth-closet depends. The earth should be dried in the sun and be pulverized, for the further it is subdivided the more effective it is. Clods and caked earth act only through their superficies. When dried artificially as sometimes is necessary, there is great risk that the beneficent bacteria may be killed by excess of heat. The chief disinfectant use of dried earth is with fæcal discharges, and about a pound and a half should be applied to each evacuation. It is upon this principle, not merely to put them out of sight, that open-air evacuations should be immediately covered, and the soil to cover in at the sinks be kept as dry and as fine as possible. Coal ashes are not desirable for this purpose, and the addition of an artificial deodorant may antagonize the natural agents in the soil.

Sulphur dioxide

Sulphur burned in the presence of oxygen, as in the air, generates sulphur dioxide. This is a rough-and-ready way of developing a bad odor, a gas irrespirable by man, and a germicide as to whose value authorities are at variance. When sufficiently concentrated it destroys moderately resistant germs. As it puts an end to animal life, it is well adapted to the fumigation of transports, store-houses and other magazines that may be overrun with insects and rats.

Chlorine

Chlorine is also an irritant gas and like sulphur is a decolorizer. It may be generated by the action of hydrochloric acid on manganese dioxide. Its high specific gravity renders crevices above the level of the distributing vessel difficult of access, but when it is well done chlorine disinfection is efficient. A more convenient method is to wash down the apartment in all its parts by a one per cent. solution of chlorinated lime. The chlorine continues to be given off until the entire substance is decomposed. As a precaution this should be repeated several times.* For every 600 feet of surface 8 ounces of this lime and 3 pints of water would be enough for one washing. Chlorinated (or chloride of) lime destroys most odors of decomposition, and on that account is chiefly used where decay is occurring. To scatter it upon the surface of such a mass by no means implies its penetration.

Chloride of lime

Quick-lime

The ordinary commercial lime, freshly made, is a valuable disinfectant for open sinks and to throw upon fæcal deposits which, in spite of orders, new troops make in unauthorized places under cover of night. This latter use serves a double end; it neutralizes the discharge and marks the spot. To be effective the lime must be newly burned, that is, be quick-lime. In that state it neutralizes the commoner bacteria. Air-slaked, it is valueless for disinfection. As it is bulky, for an amount equal to that of the fæcal matter is required for incorporation therewith, and it therefore may tax the wagon transportation, as it must be carefully stored out of the rain, as it becomes air-slaked by long keeping, and as lime cannot be had near at hand everywhere, quick-lime is not always available for camps. But where it can be had it is very useful, and usually it is cheap. It may be used dry, or in strong solution as "milk of lime." Its common use as lime-wash on walls and out-houses speaks for itself.

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* Notter and Firth: *Hygiene*, 3d ed., p. 753.

Corrosive sublimate (bichloride of mercury, mercuric chloride) has the advantage of extreme portability and the disadvantage of being very poisonous. It has the further disadvantage of forming an insoluble coating with the albumen of the excretions it is designed to sterilize, thus itself depriving their interior of its own action, although this may be overcome by making the solution to be used acid; and it corrodes metal utensils and pipes. It is of greater service in a post, where a 1 to 1,000 solution is valuable for washing down infected walls after fumigation or aërial disinfection. For privy-vaults one pound of corrosive sublimate dissolved in much water may be used to 500 pounds of the estimated contents. On account of its very poisonous qualities, corrosive sublimate should be kept in store only by the medical department, for issue as required.

Corrosive sublimate

The essential chemical principles contained in carbolic acid (the higher phenols) are valuable bactericides and are probably the most convenient of all the effective agents for field use. A 5 per cent. solution of carbolic acid is effective against most disease-causing germs. Under the name of cresol these phenols are found in the market in combination as very serviceable emulsions, of twice the strength of carbolic acid, and they are sufficiently portable and inexpensive to be used freely in the field.

Carbolic acid

Cresol

Formaldehyde, generated by the action of heat (from a special lamp) on wood alcohol, is an efficient gaseous germicide for exposed micro-organisms. It will not penetrate fabrics deeply, and it kills mosquitoes only when brought with sufficient concentration into direct contact with them. Formalin is a 40 per cent. solution of formaldehyde, and has all the acceptable qualities required of a disinfectant when it is brought into contact with bacteria. " A 10 per cent. solution mixed with fæcal discharges renders them odorless at once, and completely sterile within an hour." *

Formaldehyde

Formalin

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* Havard: *Military Hygiene,* p. 446.

In these outlines of disinfection nothing more has been sought than to supply the line officer with a scheme through which he may appreciate medical advice, or in emergency and for the time act himself for the protection of his men.

To officers of the organized militia, many of whom may one day command volunteers, and to intelligent soldiers who may aspire to commissions, sanitation should appeal with peculiar interest. The regulars inherit a mass of traditions and methods known as the custom of the service, which includes forms for garrison and field life under a kind of rule of thumb. Some of these are poor, but the most, derived from experience, are good. In the nature of the case the militia and the volunteers do not have these to fall back upon; hence the importance of learning the reasons as well as the methods of their new life.

For regulars and volunteers alike the conclusion of the whole matter is that the care of troops, or the practice of military sanitation, is a continuing service full of prosaic detail act by act. But it is of great public as well as professional importance, as measured by its development of the military arm upon whose combined vigor and skill the security of the commonwealth at times must rest. History plainly shows armies wasted, not through ignorance of tactics, but because of the neglect of that strategy which involves the realization of military limitations as well as of capabilities and opportunities. The medical director should be a trusted counsellor of the commanding general, but to weigh his advice the general must appreciate it.

The minutiæ of this duty expand naturally, so that the care of an armed man and that of an army are problems of the same factors, only varying in their power, in the science of military hygiene. The company officers and their immediate superiors should extend constant and intelligent supervision to all the enlisted men, whose physical energy alone makes success possible, but whose position precludes initiative and who may be forced into unavoidable impotence. In addition to physical care this involves cultivating the moral qualities of contentment, and of personal and patriotic pride in the profession of arms. The substructure of the whole is bodily and mental vigor. No army handicapped by unnecessary illness nor crippled by self-imposed disabilities can properly serve the republic. To maintain its efficiency requires the intelligent coöperation of all grades and all branches of the service.

XXXII

THE CARE OF TROOPS IN THE FIELD

The very first element in the efficiency of an army is its health. The success of a campaign depends upon hostile contact, actual as in battle or potential as in manœuvres; but in either form those operations require vigorous men for their execution. As every student of military affairs knows, the deaths in the field from disease far exceed those from the casualties of action, and the discharges for disability for illness greatly outnumber those for wounds. It is also true that the newer the troops the more sickly are they, so that sometimes the ranks are much reduced before the enemy is found. That is, it is the camp and not the battle that at first and most seriously disables men. The prevention of very much of this disease lies in the hands of officers of the line. Medical officers may point out the methods of prevention, but their execution rests with the officers in actual command. By an intelligent application of their authority these can reduce the preventable disease to the minimum, and nearly all camp disease is preventable.

A large improvised army of seasoned troops is a contradiction of terms. Therefore when a newly-raised army is to take the field, its material should be selected as carefully as possible. Youthful recruits have little military value. Men for active service should not be less than twenty-two years of age, or they would be too immature physiologically. Immature men in the ranks require special care, because as a class their endurance and adaptability are inferior. Such soldiers succumb under the exertion and hardships that at any time may, and sometimes must, be required of them.

All collections of young men are liable to epidemics of such contagious diseases as measles, mumps, German measles, scarlet fever, as they may not have suffered from in childhood; on which account rural recruits in particular furnish a large immediate sick-list. Regiments raised directly in the country must expect to pass through a period of inefficiency from measles alone, which always ravages such commands. This is a very serious matter for adults in camp, and the colder the climate the more grave are its consequences. There is practically no way except by isolation to prevent these contagious diseases. The most that regimental officers can do is to provide abundant air-space and protection against the weather for those within range.

Rural recruits do not bear as well as those from the towns the irregular hours and the night work of military life, nor do they learn as quickly. But after they have become habituated to discipline and its requirements they are more efficient.

All recruits are apt to suffer from troubles of digestion and assimilation. The plainer food and, particularly, the cooking with which in the beginning they are supplied disturb the health of many, and one of the first duties of a company commander is to secure a really competent field cook for his men. Intelligent assistants should then be detailed in succession, so as to spread a knowledge of the preparation of food as rapidly as possible. When every man can acceptably cook his own ration under the conditions of the bivouac, that command has reached a high state of efficiency and nothing less than that is satisfactory. It is in this respect that volunteers, and especially the organized militia, are often woefully at fault. When called into service they do not know how to prepare their food. Training of this kind, instead of dependence upon hired caterers in their summer camps, would add immeasurably to their efficiency when mustered in. The National Guard should understand that military cooking is more important than markmanship in the early days of a campaign. It is useless to place in front of the enemy, or indeed to hold in reserve, men however well equipped who cannot keep the field in vigor from inability to subsist on the food as furnished. However abundantly the commissariat may be supplied, only that food benefits the soldier which is well cooked and, moreover, is digested and assimilated. It is the food in the blood, not in the kitchen, which supplies vital force. On account of the common difficulty with field food at the beginning, an extra supply of good bread should always be provided. It is invariably acceptable to recruits, it is a good diet, and none of it goes to waste.

The most important single article of uniform is the shoe, and it is a company officer's duty to see that his men are properly equipped in that way as soon as they are mustered in. Nor should he be satisfied with seeing that shoes are issued. He must satisfy himself that they surely fit. Besides, a real march should not be begun in new shoes, whether they fit or do not, until they have been well oiled and made supple. The soldier's marching capacity depends upon the character of his foot-gear, and it is also in this respect that the organized militia when mustered in with State equipment are apt to be defective, because so many of those men wear their civilian's shoe under military conditions. When the shoe is not issued by the State, the Guardsman should be required to keep a serviceable pair of marching shoes with his arms and in equal condition for use. One of the most painful trials for all troops beginning a campaign, whether otherwise trained or not, is foot-soreness. The almost invariable attempt of raw troops to make an excessive march in every-day shoes leads to a great deal of avoidable agony. The military shoe as issued is not ideal, but it is much better than what the soldier will buy and wear if not prevented. No man should be excused from wearing the regulation shoe, unless under very exceptional circumstances certified by a medical officer of experience. To be serviceable, a marching-shoe should be large enough in all directions, but not too large. When the foot moves within the shoe it is quite apt to develop chafes. The shoes should be made supple with oil, and for better endurance have hobnails in the sole. The company officer should convince himself by direct and repeated personal inspection that his men's feet are properly cared for as to nails, and in the absence of corns and bunions. Men should be instructed to cut the nails square across, not rounded, a *little* but not far behind the end of the toe. Especially when there is a tendency to grow in, the corner of the nail must not be rounded.

Before a march the foot should be well greased with tallow or neat's-foot oil (but these are not easily had in the field), or the inside of the stocking should be covered with a stiff lather, carefully rubbed in, of soap. The common yellow soap, always at hand, is too irritating except for well hardened feet, although it was in well established use with the older soldiers. The blander soaps serve better. Should the stockings excite pain on a prolonged march, the pressure is sometimes relieved by changing them to the other feet or by turning them inside out. Plain rags wrapped around the feet are an efficient substitute for stockings, that sometimes are very comfortable and always are much cleaner. A blister on the foot should be opened by only a prick at the lowest point. Or better if practicable, pass a threaded needle through it and tie the ends of the thread together. This will drain the fluid without disturbing the delicate skin. The next day the ends of the thread may be cut off, but the inner part should not be removed. To soak the feet in water, especially cold water, although grateful at the time, is of doubtful advantage. It is better to wipe them carefully with a damp towel or to bathe them gently with tepid water and rub in an animal oil. The latter is hardly practicable on a march. Chafed and inflamed surfaces should be well greased or be covered with a clay poultice (Sundberg). The salicylic and talcum foot-powder or ointment within the stocking is particularly efficacious. Spare stockings should be put on at the end of the march, and those worn during the day be dried and beaten, or if possible be washed, for the morrow.

Individual cleanliness is a material factor of health and efficiency, and the stated inspections by company officers should embrace the condition of the person and of the underclothing. At least once a week at an inspection, combined with the daily inspection of quarters or not, the actual condition should be observed under commands similar to these: "Remove both shoes and one stocking! Open coats and shirts! Non-commissioned officers excepted." Uncleanliness thus observed should be followed up. An inspection confined to the outer dress and satisfied with clean spare underclothing in the blanket-roll, regardless of what may be on the person, is unworthy the name and encourages concealment. This is the more important with new troops, because with some of them exact care of the person is an unfamiliar task and to all the meagre accommodations of the field interpose obstacles. Recruits require nearly as much supervisory care as children, and it should be given unremittingly and intelligently until they become adapted to their new life. On that account, that they may see as well as hear what to do, it is very desirable to assign regular recruits to organized companies as promptly as they are sufficiently drilled not to destroy the formation. And it is equally important to introduce a few good old soldiers, if they can be found, into volunteer organizations. But pains should be taken that such men shall be cheerful, not grumblers, if possible. After new soldiers truly pass out of the recruit stage this vigilance may be relaxed, and at no time should concern degenerate into friction and worry. Perpetual nagging — too curious supervision — is almost as bad as contemptuous neglect.

Where water is scarce, a very small quantity, a quart, with a small sponge or a damp towel, is sufficient for cleanliness. Where it is abundant, plunge bathing should be encouraged, except in the very heat of the day or near nightfall. Soldiers should be encouraged to carry a cake of soap, in a small flannel bag to avoid waste. For officers, soap "leaves" in a small water-proof box, to be carried in the pocket, are most convenient. Every prolonged campaign where opportunities for the care of the person are deficient is marked by the presence of vermin. These may affect any grade. The odor of musk is said to be deterrent, but it can only be used exceptionally. To thoroughly boil the clothing or to soak it in sea-water or other brine is the simplest way of destroying the infection. To soak infected clothing in a barrel of water containing a handful of "fish berries" (*cocculus indicus*) is said on good authority to be efficacious. A careful captain, later a general officer, has been known to carry these with his company property for this especial purpose.

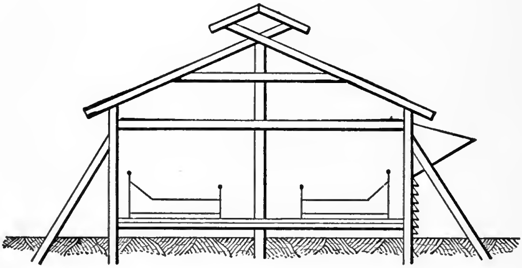
New soldiers invariably begin field service by attempting to carry too much, and then very soon they abandon necessary things. There should be prepared in advance two schedules, one of articles that must and another of such as may be carried. The limit of the first should not be lowered nor that of the second be exceeded. But after six months the second schedule may be abandoned in view of the experience acquired. On daily marches it is found that washing the face and neck on rising is not well, probably because the removal of the natural secretion makes the skin more susceptible to the dust and heat of the route. To wash the eyes and mouth and use a damp towel on the face and neck is preferable. When camp is reached the entire body if possible, and invariably the head, the genitals and adjacent folds, and the feet, are to be washed. Soldiers' hair should always be kept short.

When lying out of barracks, soil-dampness should always be guarded against by an impermeable sheet, as the rubber blanket, between the man and the ground, or the soldier should have a few inches of air-space under him. In a wooded country immediate steps should be taken to build platforms at least two and better four feet from the soil upon which the tents may rest. The natural sod should not be removed. To raise the tent thus is not difficult, and it has secured immunity from soil-diseases for an entire command owing to the air-swept space under the sleepers. If the tents cannot be elevated, bunks must be raised well above the ground. Even with shelter tents, there should be some approach to this. Under no circumstances should the men sleep directly on the soil, and whatever constitutes the floor, whether boards, boughs, or straw, must be removed and the surface swept and exposed to the air, and if possible to the sun, every dry day. Tent walls should rarely be raised to windward after nightfall. Vegetation liable to decay is not healthful to sleep upon.

Except under overruling military objections, which would rarely occur, tents should open to the east, and the southern wall be raised in good weather after the day is advanced, so that sunlight may search it throughout. Tents not on elevated platforms should be moved weekly to the alternate spaces that would remain in the lines.

Every tent should be ditched as soon as pitched. That is a good rule for all camps not in rainless regions, and an imperative one in damp places. In any climate dampness of a tent floor is harmful. On the second day at the latest, company and other streets should be prepared. These and a general system of superficial drainage are everywhere essential for comfort and in wet climates for health.

It by no means follows that because a command is in the field it has an adequate air-supply. Canvas when wet is practically impermeable to the air, and in a wooded or chapparal country there may be little movement of the atmosphere. Camps may readily be too compact, and troops marching in close order are liable to modified crowd-poisoning. The utmost extension of a camp that military considerations will permit, within the limits of reasonable police supervision, is always necessary, especially in a hot country. In hot weather all tents, shelter or other, standing more than one night should be protected overhead by a brush canopy, and brush arbors in front of tents should be built by the second day. These should be arranged to protect from the sun with the least interference with the wind. In camps of any duration vegetable decay from these shades must be guarded against. For camps of position portable huts or sheds may be furnished. These, whose frames may be of wood or iron, should have ridge ventilation from rafters crossing beyond the true peak, louvered lateral openings in the wall, and a steep roof to throw off the rain. Temporary huts of the same general character with fairly open walls can speedily be built where there is light timber. They need not be more than 16 feet wide nor 10 feet to the eaves. Every structure for habitation should be ditched as carefully as the tents, and by preference be raised on posts well off the ground. In cold weather it should be well banked. If the floor is not raised, the boards should be fastened with screws and be frequently removed. As with tents, the principles of dry soil, a free air-space under the floor, and abundant ventilation and sunlight should be maintained.



Portable hut. From Notter and Firth's Hygiene (By the courtesy of Messrs. P. Blakiston & Co.)

Notwithstanding air may have free access, neither barracks nor tents should be overcrowded. Consumption spreads readily under such circumstances the world over. In all stationary camps the men develop a tendency to accumulate useless articles. These are hurtful by interfering with the living space, harboring dust, and sometimes promoting decay, and should relentlessly be condemned. At every daily inspection in dry weather the floor should be absolutely bare, and the ground beneath it be observed.

The proper police of all military camps is important, particularly in southern climates where the combination of heat and moisture leads to the rapid decomposition of waste and encourages the plague of flies. Hence all refuse should be promptly removed without the lines and everything that is combustible be burned. Incombustible material should be buried in trenches, partly for the sake of order and partly that no débris in sight may serve as an excuse for other such neglect. Kitchen waste should be disposed of twice daily.

The sinks, miscalled latrines except when there is water carriage, on every account require the greatest care. They should be placed to leeward if possible, and always no farther away than absolutely necessary, for when properly cared for they need not offend the sense of smell or of sight. The company kitchens and the general sinks should be on opposite sides of the camp; for it is well established that some diseases may be communicated by flies that have alighted in sinks transferring with their feet infected particles of filth to prepared food in the hands of the cooks or of the men. It is imperative that sinks should not drain toward the water-supply. Each sink should be from 12 to 20 feet long, by 5 to 8 or more feet deep, if intended for use more than twenty-four hours. It is better to multiply the sinks than to make them too long. In each case all the earth should be thrown to the rear and the more nearly pulverized it can be kept, the better. For a single day's use, 3 feet is deep enough. But sinks should be dug immediately for every part of a command of any size. It is only a small body of actively moving troops, that will not be followed by others, that can afford to dispense with them for a single night. In that case, as well as before sinks are dug if there is even trifling delay, a small area must be set apart to leeward where men may relieve themselves. When this is done and the men are equipped with an intrenching tool, each man should be required to cover immediately his evacuations with fresh earth and not merely to scratch loose dirt over them. Where there are no tools they are to be covered with equal care by an extemporized implement. The use of sinks or of a limited locality should be strictly enforced. There is no more distinct sign of ill-disciplined troops than the soil pollution that follows such neglect. Sinks should be screened by bushes and be covered from the sun when possible. In wet seasons old canvas may be reserved to protect in part from the rain. Under the same conditions the excavated earth should be kept dry as far as may be. The individual deposits should be covered with earth at the time, and, besides, a full layer of dry earth should be thrown in evenly at least thrice daily — at retreat, after breakfast, and at noon. If lime can be procured, it should be added if there is the least evidence of dysentery in the command, for dysentery may be contracted by the well who frequent foul latrines used by such sick. To burn a little mineral oil on paper or straw thrown into the sink helps to keep down the flies. When within two feet of the surface the sink should be filled in, rounded over, distinctly marked, and a new one prepared in the same general neighborhood. All sinks should be filled in on breaking camp and all débris burned, if there is no military objection to the smoke from the fires. Officers' sinks should have box seats open to the rear, and be well protected in front, rear, and overhead. Urinals should be arranged in convenient places in a camp of permanence, and their use compelled; for it is perfectly possible to communicate such a disease as typhoid fever by urine indiscriminately voided. Besides, the annoyance from ammonical decomposition is very serious. The sinks used by the sick are to be disinfected as the medical officer may direct, and all sinks are to be inspected daily by the officer of the day in addition to the medical officer's inspection.

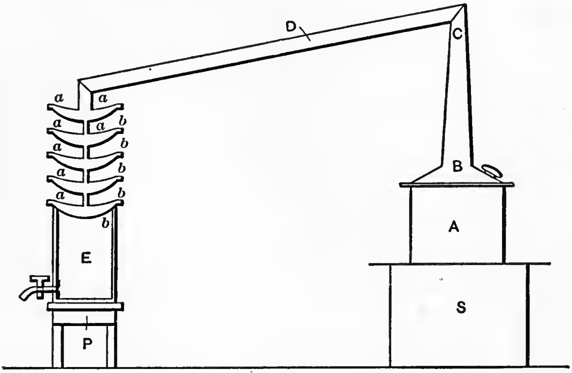
Cheerfulness is absolutely necessary for a healthy camp. The two elements that insure this are occupation and amusement. *Ennui* is the parent of discontent and homesickness. Discontent spoils the best soldier, and homesickness is a most depressing disease. Regular occupation besides drills, is necessary. After a camp is well established work, preferably of a military character, should be found, as for instance the making of field defences, or of gabions and fascines. This should not be carried to exhaustion, nor to prevent any leisure. At the same time athletic games should be encouraged and if necessary be organized and contests arranged. One of the tests of an officer's fitness for his commission is his ability to interest his men in such matters. Music is always stimulating, and martial music is a great solace in the discomfort of the field. Gambling, to which many men will resort in the absence of rational amusement, is hurtful physically and morally. It tends to keep men out of the fresh air in crowded groups and constrained positions, it encourages nearly all of the baser emotions, and is a great obstacle to discipline in peace or war. When circumstances permit, short marches, especially with all the forms of war, are exciting and instructive. Commendatory orders by the brigade and regimental commanders for the neatest regimental camps and company streets, and for the regiment and company freest from preventable disease, encourage the better men. This principle of commendation is applicable to divisions and corps.

There are two great classes of diseases, the intestinal and the malarial, that threaten and generally afflict an army in the field in the warmer climates, and in the American tropics a third, yellow fever, that is greatly to be dreaded. All of these are preventable in the sense of being avoidable. The exposures of field life are often followed by their attacks, but they frequently occur because perfectly practicable precautions have been neglected.

The intestinal diseases proper that befall an army, especially in the South, are temporary looseness of the bowels, a debilitating and persistent diarrhœa, and dysentery, acute and chronic, always serious and often dangerous. These all may occur in succession in the same person. Typhoid fever, which is apt to invade and is sure to spread in ill-kept camps, has its main seat in the bowels and is propagated by their discharges. All these are avoidable by mature and healthy men; or, more strictly, they only occur after violation of personal or general hygiene. Malarial infection weakens the natural powers of resistance and may complicate any of the diseases mentioned. There is therefore a particular reason for guarding against it, as presently to be described. The cautions to be observed by line officers in these respects in the care of those under them are as follows:

As popularly recognized, errors of diet are a common cause of diarrhœa. Recruits often suffer from diarrhœa even in garrison, simply because of unaccustomed food; and all but seasoned men are liable to it when the conditions of camp cooking are first encountered. If the food itself is sound and is properly prepared, this will soon pass away. But careful and intelligent supervision of the kitchens and the mess is necessary.

Water quite free from specific disease-causes may induce diarrhœa, that may become very serious in susceptible persons. Hard water, chiefly from lime and magnesium salts, may be modified by boiling. But generally speaking, the system becomes habituated to it, especially if it is drank sparingly at first. To drink from alluvial rivers filled with suspended clay will induce diarrhœa in unaccustomed persons, and sometimes in all. Such water will frequently become clear by merely standing for twenty-four hours (sedimentation). Filtering slowly through flannel detains much of the mud, but the flannel must frequently be changed or washed. Chopped cactus-leaves have a clarifying effect, and an excellent agent is alum, in the proportion of six grains to the gallon, stirred in the water to carry the clay down as a precipitate. Some such precaution is necessary with the water of muddy rivers. Occasionally it is found that water charged with vegetable débris causes diarrhœa, but is harmless when filtered. Brackish water from near the sea may cause diarrhœa, when the only preventive would be distillation. The same is true of alkaline water. A small but effective distilling apparatus can be constructed by the aid of a kerosene lamp, a small metal tank, a few feet of pipe, and a receiving vessel. This is not nearly as complicated as it appears, is very portable and inexpensive, and is particularly adaptable to small commands. The stands P and S can be extemporized in any camp.



Still for alkaline water.

A, tin boiler.
B, tin funnel-top.
C, sleeve of 2-inch pipe *D*.
E, jar, preferably earthen.
S, *P*, stands.
ab, condensing plates, pressed tin.
a, one inch deep; *b*, three inches deep.

A 1-inch tube 3 inches long is soldered to the top of *a*, and a tube 2 inches long, to slide into the other, is soldered to the bottom of *b*.

If *A* is 16 inches square, each perpendicular inch will contain 256 square inches or a little more than the United States gallon (231 inches).

From the design of Major Alfred E. Sears, by the courtesy of The Medical Record.

For permanent posts, when required, the Quartermaster's Department will supply distilling apparatus on a large scale, and for camps where the water is doubtful filters and sterilizers are furnished. Practicable filters of sand and gravel in casks can be extemporized in the field for temporary use. But boiling is the safest process.

One, but not the sole cause of dysentery, very serious and very common in the tropics, is water polluted with excremental matter, particularly with the discharges from a previous case. Once introduced it is liable to become epidemic; hence special pains should be taken to guard the water from the very beginning, to avoid old camp-grounds and occasionally to occupy a new site. Where the purity of the water is maintained, much freedom from this disease is assured. Where the water is impure or even doubtful, every drop drank or used with food should be boiled, whether in camp or while marching. With fairly disciplined troops this is perfectly feasible.

Both typhoid fever and dysentery may, however, be propagated by minute particles of excreta, or the bacteria from them, attached to food or driven as dust into the mouth. Hence scrupulous police care should be enforced within the habitable limits of the camp and upon its confines. It is certain that the painless diarrhœa of the unrecognized first stage of true typhoid fever is infective, which is an additional reason to those of abstract cleanliness for the careful control of all evacuations.

Tropical dysentery is very persistent and readily reasserts itself. A convalescent therefrom is not fit for the field until long after he seems to be well. Typhoid fever disqualifies a soldier for at least three months, on account of changes in some of the inner organs, and company officers should always be prepared to lose the services of such men for prolonged periods.

The malarial diseases are represented by the intermittent fevers, from the common ague to the crushing pernicious or congestive chill that destroys life at a single blow; by the remittent (autumnal) fevers, from those familiar to most residents of the southern states to the Chagres and jungle fevers of the tropics; and by complications of various other well-known diseases. In the tropics these are most prevalent in the spring and autumn, the maximum coinciding with the close of the rainy season.

The efficient cause of malarial disease is a plasmodium which in various forms, infects the blood. This has not yet been isolated outside of the human body, except in a genus of the mosquito (*anopheles*) which acts as an intermediate host and transfers it from man to man. This demonstrated fact completely accounts for all the presumed methods of its spread formerly accepted, except possibly its absorption in drinking-water. Those most susceptible to its action are the weary, hungry, and ill-conditioned, and those weakened by excesses. If the possibility of drinking infected water be rejected, and there is no positive evidence that the disease may be communicated in that way, the prevention of malaria in the field is summed up in the exclusion of the mosquito. In its final expression this is by the use of nets or of some deterrent application. Contributing measures are such as these: In selecting a dry site for a camp; in encamping to the windward of marshes; in avoiding unnecessary exposure after the sun sets and until it has well risen; in being reasonably clothed, especially during sleep, with light woollen or merino or at least loosely-woven cotton; in having the floor of the tent or sleeping-place raised several feet from the ground, which is practicable in permanent camps, and is important, but is rarely done; in drinking only water that has been boiled, which is particularly important and easily arranged; in supplying the men on night duty with hot food, such as oatmeal gruel, early in the evening, and with hot coffee and hard bread near midnight and again near dawn; and in the systematic preventive use of quinine for those particularly exposed, and of curative doses on the slightest suspicion of a malarial invasion. All of these precautions cannot be taken in the immediate presence of the enemy, against whom military operations of attack or defence may be of primary importance; but it is astonishing how much that is preventive may be done ordinarily by systematic and intelligent forethought. The delay of a few nights in a highly malarious region may weaken an army more than a sharp engagement. Even where the locality is not "pernicious" in the technical sense, prolonged residence in an unhealthy situation depresses the men physically and morally by the resulting sickness and death. For instance, it is probable that the Army of the Potomac, notwithstanding it compelled a bloodless evacuation, lost more men during the month it lay in front of Yorktown in the spring of 1862, and subsequently as a consequence of that camp, than would have fallen under an immediate assault.

Other precautions that always may be taken are:

(1) Every soldier may wear a light woollen suit next to the skin. That is a matter of equipment first and of discipline afterward. It is useless to supply men with heavy woollen underwear in a hot climate and to expect it to be worn. It becomes insufferable, and will be abandoned or destroyed. The temptation with ill-disciplined troops is to do the same even with very light flannel; but, partly by explanation and partly by rigid discipline, they may be held to it until it is worn willingly. Its habitual use, especially at night, relieves the body from the risk of debilitating chill.

(2) To drink only water that has been well and comparatively recently boiled. Water for a company may be boiled wherever a camp-kettle can be carried; and every man can boil his own allowance whenever he can make an individual fire for his own cup. A zealous captain will see that his men actually fill their canteens with boiled water before they fall in for the march, and that while in camp or bivouac they drink none that is raw. Well-made tea (where water that has boiled must be used) or boiled coffee is still more acceptable, and men should be encouraged to carry tea or coffee (in a vial for economy) and to boil the water in their own cups on making camp. A canteen of tea is more desirable than one of plain water. The object in drinking only boiled water is the exclusion of any other depressing pollution, as the bacillus of typhoid fever, quite regardless of the possible presence of the malarial plasmodium or its antecedent. But "it is regarded as not impossible that the drinking of water contaminated by these insects [mosquitoes] . . . may have a part in the dissemination" [of malarial fever]. (Harrington.) To boil the water devitalizes the plasmodium.

(3) When deprived of the conveniences of camp, as here supposed, preventive doses of quinine should not only be dispensed but administered, and that *without* whiskey. It is as absurd to campaign within range of malaria without using quinine as it would be to go into battle without ammunition. But the use of alcohol before or during such exposure opens the system to its attack. Hot and tolerably strong coffee is an excellent tonic under such conditions.

The foregoing represents nearly everything that can be done under those emergencies which compel active movements in malarial tracts.

Yellow fever is now known to be transmitted from man to man by the agency of the mosquito (*Stegomyia calopus*), precisely as the malarial disease is spread by the *anopheles.* It is not known to be propagated in any other way, and the disease-cause has not yet been discovered outside of man and this insect. Hence protection consists in avoiding the infected mosquito, and prevention is concerned with destroying, primarily, all the insects thus contaminated and, secondarily, those capable of becoming an intermediate host. The Army Commission under Major Walter Reed determined definitely that everything outside of these living bodies may be disregarded. The incubation in man does not exceed five days. Therefore any well man may be admitted from an infected district without fear after that period of isolation has elapsed. The infected mosquito requires twelve days for the infection to develop. It follows that all mosquitoes that have not been in contact with a yellow-fever case for a little more than twelve days are harmless. But once infected, it is believed that the insect may cause the disease for an almost indefinite time, certainly after a period of prolonged hibernation. In the field yellow fever, having occurred, will ravage a non-immune command while it remains where the disease appeared. Ultimate military success will therefore best be attained by effectually avoiding places known to be infected. Even in the tropics the removal of an infected command from bodies of water and to a height of 1,000 feet will often check the epidemic. In more temperate climates to transfer the troops, sometimes only twenty or thirty miles, into a drier and somewhat higher atmosphere will generally cause the disease to cease. In both cases presumably this is because the *Stegomyia* does not breed there, although such local exemption has not yet been demonstrated. Should the command remain stationary after the disease appears, every man who has not previously had it will certainly be attacked as long as infecting mosquitoes can reach him. The accession of frost sets the only natural limitation to their ravages. The mortality from yellow fever is always high, and men broken by excess, especially alcoholics, almost certainly succumb when attacked. It is the true policy, whenever practicable, to manœuvre oneself out of and the enemy into the yellow-fever region. Both malarial and yellow-fever cases are always to be regarded as infecting centres, not to be avoided by the well for fear of direct infection, but to be protected by netting and otherwise from those insects that imbibe, develop, and transmit such infection.

Independently of specific causes of diseases as noted above, there are other avoidable conditions which frequently lead to illness in warm climates. One of the most important is the effect of heat and cold, and particularly changes from one to the other, in causing diarrhœa and dysentery. Men become chilled at night, or by the evaporation of perspiration after exertion, when the bowels soon suffer. Systematic attention to so simple a matter as insuring that men are properly covered at night is important. Young soldiers, and particularly those unaccustomed to camp, cannot be depended upon to care for themselves, but the captain who makes sure that his men *are* thus protected will be certain of a stronger and more willing command. The bowels lie so near the wall of the abdomen that the circulation there, on whose disturbance this form of diarrhœa primarily depends, is easily deranged by changes of temperature.

The cummerbund of the Asiatics and the cholera belt of Eastern travellers, evolved by experience, are intended to equalize the abdominal circulation. More convenient than these and more efficient is a flannel apron, of one or two thicknesses, from 14 to 18 inches in width and from 6 to 8 in depth, tied by a tape around the waist and worn directly next the skin. This apron is quite different from the official belt that has been issued, which is apt, when it is unwillingly worn, to become an ineffectual and annoying roll about the waist. It lies in place, is easily tolerated, and generally prevents or controls the simple diarrhœa and light dysentery of either hot or cold climates that depend upon disturbances of the local circulation. The apron is not issued by the government, but it is procurable, and every commanding officer in hot climates should insist that his men are provided with two apiece, and should verify by irregular inspections that one of them is constantly worn. To some officers such attention to the individual men as is implied in these paragraphs does not appeal. But to those who remember how frequently soldiers are exposed to illness, partly from ignorance and partly from helplessness, this form of duty becomes a pleasure that meets a most effectual reward.

One of the direct effects of extreme heat is sunstroke, or heat-exhaustion, and when high temperature is long continued there is a general depression quite independent of such direct causes as the malarial or other poisons. The head covering should be light in weight and in color, be permeable to the air, and have an air-space all around as well as above the head. When directly exposed to the sun, a wet sponge or wet muslin worn in the crown lessens the risk. Experience shows that the second great nervous centre, the spinal cord, should not be exposed directly to the sun for a length of time. All the clothing should be loose, especially about the neck and chest, and the pack that may require to be borne should stand away from the body. The general depression from long-continued heat is intensified in a moist climate by imperfect ventilation.

As the companies fall in for a march or similar duty, inspection of canteens should show them filled with pure water, preferably boiled, or weak tea. In temperate climates men should be discouraged from drinking *en route.* Once begun, the almost irresistible temptation is to drink frequently and then to replenish the canteen from the nearest water regardless of quality. The sensation of ordinary thirst arises from dryness of the fauces, and if these are moistened by the saliva excited by chewing there is great relief. To that end it is better to supply the system by a reasonable draught of water before starting, and to keep a pebble or a bit of wood in the mouth to excite moisture, but not to drink a drop, except there may be a halt for luncheon, until the camp for the day is in sight. In the tropics this rule must be somewhat modified, for too great loss of fluid by perspiration predisposes to heat prostration, and a part of the liquid must be replaced. But whatever is drank while marching should be limited in amount and be taken at considerable intervals, and the men should be particularly cautioned against drinking much early on the way. Exact and arbitrary control over the use of the canteen is impracticable and would be unwise, but through their non-commissioned officers the privates must constantly be instructed, until from reason and experience the habit of abstinence is acquired and they learn that tropical water must be boiled. But, as Smart points out, under a blazing tropical sun a fulminant heat-stroke is better avoided by using a stinted but steady supply than by drinking copiously with a period of enforced abstinence following.

The question of diet in an unaccustomed climate is a vexed one. It is a good general rule to follow the habits of intelligent natives without changing too suddenly from the usual food. All food in hot climates is prone to decay, but nothing should be eaten that is open to suspicion. Natives frequently consume decomposing food with impunity, and in that respect their example is not to be followed. When ripe and perfectly sound, fruit is generally unobjectionable; but within the tropics the least spot upon it indicating decay should condemn the whole. The difficulty of enforcing this rule with soldiers leads to the more general one of forbidding all fruit. This is not a necessity, but is an effort to avoid a frequent evil.

Alcohol in any form and to any degree as a beverage is harmful, and when taken beyond moderation is dangerous. It is true the world over that a drunken camp is a sickly camp, and in hot climates drinking, even short of excess, tends directly to disease.

Properly to conduct a march requires experience, or a greater attention to theory than frequently is given. Except the necessity be very pressing, the first march with troops unseasoned in marching, however well they may be drilled otherwise, should be but a very few miles, barely enough to clear the old camps, for at the outset there is friction everywhere. Each day's march may be gradually increased until in about a fortnight the maximum will be reached. By this gradual development much better results can be secured in a given time than would be were a specified distance equally divided through a given number of days. Every eight or ten days, besides Sundays, there should be a halt for rest and repairs. Under pressure seasoned infantry will make almost incredible distances and great speed, as witness Crawfurd's Light Division in the Peninsular War and "Stonewall" Jackson's command in our Civil War. Enthusiastic cavalrymen are unwilling to admit it, but it appears true that seasoned infantry will outmarch mounted troops in a long campaign. Good marching is the complement of good fighting, and the most famous and effective troops are those that reach the objective the soonest; but no troops can march their best until they are taught. The ease with which troops march is inversely to the size of the command; thus a regiment moves more easily than a division, a division better than a corps. Over good roads fourteen miles in ten hours is good marching for a large army, but a regiment will easily make that distance in four hours including halts. Infantry and mounted troops should not march together if it can be avoided, and infantry should march with as wide a front and in as open order as possible, for crowd-poisoning follows the collection of dirty, heated men out of doors as well as within houses. After the first few regiments, troops almost invariably march in dust or mud, and close order is very distressing. With a large command, if it is possible to move troops in columns parallel to the roads so as to leave these free for the trains, it should always be done, for it is a great comfort to have the wagons at hand when camp is made. Unless the command is very small, the men should be required to pay no attention to the minor obstacles of mud, water, and the like; for hesitation in the leading files is magnified into serious halts at the rear, and a jerky progress is very trying. But it is an economy of time to have fallen trees that partly obstruct the way entirely removed. Under the best circumstances even good troops will lose distance, and frequent halts are necessary or the rear will be a state of perpetual worry in the effort to close up. No particular command should be moved on until it is well closed up in the rear and the rear ranks have rested. The first halt would better be at the end of half an hour, and be used by the men in relieving themselves and adjusting their clothes and their burdens. There should be a halt for five or ten minutes (as prescribed) at the end of every subsequent hour, when the men should be encouraged to spread out and rest, but never be allowed to straggle from the column for any purpose. The length of all occasional halts when foreseen should be announced at the beginning and passed down the column, for uncertainty destroys much of the benefit of the rest. Even in those accidental stops that occur in every column, should the regimental or other commanders take pains to discover the probable delay and communicate it by special signal in order that the men might rest, their strength and temper would be much conserved. Few conditions are more trying to men under arms than to await on their feet an uncertain advance. The French use a device to save time in resuming the march and to keep the men out of the mud, where squads of twenty or thirty form a circle and each man sits on the knees of the man in rear. At formal halts to get the full advantage of rest the men should lie flat on their backs with their belts loosened, but with a slicker or other protection between their bodies and damp ground.

Straggling, the loitering behind of the sick, the tired, the lazy, the ill-disciplined, is an evil indirectly affecting the health and the *morale*, and directly concerning the military vigor of the column. Its prevention, so far as those out of health are concerned, depends upon the prompt and rigid scrutiny by the medical officers of all who fall out claiming to be sick and their immediate disposition. All not adjudged sick should be promptly returned to the ranks or, in common with the other stragglers, be taken in charge by the provost guard. It is better that those really unfit should be provided with a formal ticket describing them, naming their presumed disability and distinctly defining from what they are excused. Such details, however, may safely be left to the administration of the medical department. But any man out of ranks without the written permission of his company commander on a prearranged card should be assumed a straggler, unless showing *prima facie* evidence of illness. Men fairly tired out will often be brought up fresh at the end of a few hours' transportation, but this privilege is so liable to abuse that it should rarely be given. But the really ill are to be carefully carried, for with good troops one should take the most thoughtful care of them, because then they will put forth their best efforts in the belief that they will be protected and restored when disabled. For this reason, among others, it is important that its ambulance-train should immediately follow each division. Under exceptional circumstances one or more ambulances should accompany each brigade.

The music of the fife and drum is of material assistance to a tired column, and even the steady drum tap alone helps the pace of the weary. The men should always be encouraged to sing on the march, for the more cheerful a command the more easily it moves.

It is usually an error to break camp before day, as is sometimes done, and night marches are to be avoided if possible. In non-malarious regions in hot weather an occasional night march under a light moon is a relief, but as a rule the loss of sleep and the general discomfort thus caused out-balance any ordinary advantage. Should a military necessity compel a night march in a malarious region, a preventive dose of quinine ought to be administered to every one involved, as should be done in other night duty. In a very hot climate marches should be so regulated that the sun may not shine directly on the men's backs, because extreme heat on the spinal column is harmful. This is important and frequently has been neglected.

In conclusion, it must always be remembered that men abruptly transferred from civil life to the field have new and artificial circumstances to which to adapt themselves, and in proportion as their own freedom of action is restrained does the responsibility of the officers in direct command increase. That responsibility is not limited to instruction in drill, but runs, coëqual with their authority, over every condition and detail of military life. The care of troops is a serious and constant matter of daily duty, which may be neglected but cannot be evaded; and as a rule the proportion of men presenting themselves as sick is an index of the intelligence and fidelity with which that duty is discharged. For, reduced to its final expression, the efficiency of a command is measured by the intelligent care that has been bestowed upon it.

XXXIII

ASEPSIS AS APPLIED TO WOUNDS

In addition to the mechanical injury inflicted by a bullet, the wound is liable to inflammation and discharge. That was formerly regarded as necessary after gunshot. It is now known that the inflammation is incited by the presence of infinitesimal forms of life called bacteria. These prevail on the surface of all substances, animate and inanimate, not made aseptic by special treatment, and invariably are introduced in wounds when probed or handled on the field. If they are excluded, most wounds not fatal in themselves can be treated successfully. But usually wounds become infected before a medical officer sees them. It is of the utmost importance for the men to understand that there should be no interference even with the surface of any wound, but that it should be immediately covered with the preventive dressing that every soldier carries. If that is done at once, and the hand, the clothing, and other foreign matters are kept away, there is a fair prospect of recovery in those cases that are not by their very nature and degree immediately fatal. This doctrine of non-interference and of aseptic dressing should be taught at every opportunity.

The first-aid packet, which is part of the equipment of every soldier, contains all that is necessary for the immediate care of any wound that is not complicated with severe hæmorrhage or with the fracture of a large bone. The experience of late wars shows that not only much surgical illness and suffering have been avoided, but many lives have been saved, by the immediate application of those dressings as directed, and by abstention from unprofessional interference before or afterward. Foreign bodies, including the bacteria, are kept out, so that the natural processes of healing begin and go on without interruption. The results expected to follow that simple procedure are so remarkable that the average soldier is incredulous that they will occur. He thinks that something more should be done at the time, and he fails to recognize the importance of the plain instruction to apply these sterilized dressings and to abstain from meddling. On this account the primary treatment and the consecutive non-interference should be a matter of formal and peremptory military precept from the company officers, as well as of general explanation from the medical officers.

The natural ignorance on the soldier's part of the real value of the first-aid packets, and his scepticism as to their importance even when that is explained, as well perhaps as the readiness with which they are replaced gratuitously when lost or destroyed, lead him to think lightly of keeping them intact, or indeed of keeping them at all. They are acceptable as wash-cloths and convenient for gun-rags, and where there is not reasonable discipline very many of them are wasted in that way. Besides, enormous numbers have been spoiled in tropical field service through humidity and by friction against other objects. When the moderately water-proof covering is damaged, the usefulness of the packet is diminished if not destroyed. The remedy is not merely to assign the packet to a defined position in a proper receptacle, so that it will always be carried by the man in the same place and may be found readily, but also to hold the soldier to the same responsibility for it that he has for other public property, and to verify its presence and its good condition by frequent formal inspections. When the soldier habitually regards it as United States property for which there is accountability, and not as a personal perquisite, he will pay it more respect.

XXXIV

SCHEME FOR A SANITARY INSPECTION BY COMPANY OFFICERS

In Garrison

Squad-room: Capacity and permissible number of occupants according to the sanitary standard. Number who slept in the squad-room last night. Maximum number present at any time since last inspection, with date. Floor-space per bunk. Air-space per occupant, disregarding height above 12 feet and taking account of objects in the apartment.

Illumination, natural: Arrangement and sufficiency.

Illumination, artificial: Method; number of lights; sufficiency for comfort; influence upon the air.

Sunlight: Does direct sunlight reach all parts of the room at some time of the day? If not, explain.

Heating: Method; relation to comfort of inmates; relation to air, by escape of CO or otherwise.

Ventilation: Style and sufficiency. Observe carefully at irregular intervals, and especially at night, whether the openings remain unobstructed. Is the whole room air-swept daily?

Odor: Note the degree of odor, if any, soon after midnight and again before dawn, and the state of the ventilating apparatus then.

Bunks and bedding: Inspect minutely some particular bunk for general cleanliness, and especially for freedom from vermin; inspect several for objects under the pillow or mattress, as soiled clothes, food, tobacco. Examine the under side of an occasional mattress for dust. How frequently and completely is the bedding exposed out of doors?

Cuspidors: Kind, number, and condition.

Floors: Are they clean and dry? How are they habitually cleansed? Are they ever damp?

Walls and ceilings: Are they clean and unstained by smoke or otherwise? When were they lime-washed, or they and the woodwork painted? Examine corners, the tops of the lower sashes, and behind boxes.

Lockers: Examine, not merely for order, but for dust or dirt and odor.

Barrack bags: Empty one or two at every inspection, to make certain that no improper or contraband articles are therein concealed.

Clothing not on the person: Is the uniform clean? Is the underclothing clean, or properly set apart for the wash? Examine carefully the soles of spare shoes. No shoe should bring in dirt from out of doors.

Clothing on the person: Open the coats, examine the shirt, undershirt, and the surface of the chest; examine one foot bare and the stocking on the other foot; expose and inspect the lower part of the drawers; are the head and neck and the inside of the cap clean? are the hair and beard closely trimmed? (Excuse non-commissioned officers from this personal inspection.)

Flies: If there are many flies, determine the reason. (Flies imply the presence of organic débris.)

Mosquitoes: Are there adequate nets? Are they used?

At a formal inspection insist that everything commonly in the squad-room is in place. Allow neither necessary nor extra articles to be hidden — " put away on account of inspection."

Examine every occupied room, especially those of the cooks if they sleep out of the squad-room, in the same manner.

Examine attic and general store-rooms cursorily, to see that no improper articles, as food or soiled clothes, are concealed there.

Mess-room: Examine it and the table furniture, including the under side of the table if it is reversible, for cleanliness. Inspect carefully the insides of the bowls and the tines of the forks. Examine also table furniture not actually upon the table, and the floors and windows, all for cleanliness.

Water-coolers and pitchers: Examine the interiors carefully, whereever found.

Kitchen: The interior of all cooking utensils should be scrupulously clean. Examine floors, walls, tables, and plumbing, including grease trap, if any. Knives, cleavers, strainers, should be free from débris. Inspect for roaches about range and slop-sink. Examine all food, whether cooking or in store. Especially in hot climates, see that no food is decomposing. Observe carefully the presence of flies. Examine the interior of refrigerator * daily.

Cellar: Inspect for dryness, ventilation, freedom from odor, and for condition of contents.

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* Kerosene cleans zinc, with which refrigerators, kitchen sinks, and washing troughs in lavatories are lined. But much food takes up odors so readily that it may only be used in refrigerators and other food containers when there is abundant opportunity for its evaporation.

Grounds: Inspect those immediately around the barracks and under the verandas, as for general police and for dryness. Where there is no cellar, determine the condition under the building.

Garbage barrels or cans: How frequently, how completely, and in what manner is the garbage disposed of? Is the neighboring ground polluted? Follow up in detail the disposal of waste.

Sinks and urinals: What disposition is made of body waste? Inspect carefully and frequently for interior and exterior cleanliness. If the sinks or urinals give out odor, ascertain the cause and present a remedy. If urine is voided in unauthorized places, determine the fact and stop it.

*Wash-room:** Number and condition of basins, overflow, and floors.

Bathing facilities: Examine for sufficiency, for cleanliness, and for frequency of use. Be satisfied that every soldier not sick bathes completely at stated intervals, and that the showers are efficient.

Waste water: Where there is no sewerage, what is its disposition?

Guard-house: Capacity, cleanliness, ventilation, heating, and number of occupants, of cells and of prison room separately. Prisoners may properly be uncomfortable, but their health should not be allowed to suffer in the least.

Guard-room: The guard should not be unnecessarily uncomfortable and their apartments should be well ventilated, not unduly warm, and entirely free from gross dirt. There should be facilities for preparing a hot luncheon for the reliefs going on post at and after midnight. Clothing and blankets, whether of the guard or of prisoners, should be inspected or treated for vermin before being re-introduced into the barracks.

Stables: Ventilation, light, and relation of windows to horses. Is the floor dry? If sickness among horses, examine for soil-moisture and, if necessary, recommend deep drainage. If flies are numerous, determine the cause. Note the disposition of liquid waste within and of the general manure without the stables. (Peat moss for bedding prevents ammoniacal odor in the stalls.)

Married men's quarters: Inspect every room for air-space, ventilation, light, and general cleanliness. Inspect the cellar, if any, for dampness and odor. Observe carefully the disposition of kitchen waste and of laundry slops.

Privies: In those posts or parts of posts where there is no sewerage the privies must be carefully supervised by the companies responsible, and every one should be inspected once a week. Where they are pits they should be filled with fresh earth when within two

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* Kerosene cleans zinc and most metal work well.

feet of the surface, marked, and reported to the quartermaster to be noted on the post map. No pit for this purpose should be dug without authority from the commanding officer. The vicinity of stables, corrals, wood-piles, haystacks, should be carefully inspected for superficial pollution. Each company must carefully guard against contaminating a local water-supply.

In the Field

Follow as far as applicable the form for garrison inspection. Also:

Tents: Character; number of inmates; ditched? Whether floored or not floored, is the ground dry and clean? How much above the floor is the bunk? Is the canvas sound? How ventilated, heated? How frequently removed to new site? If not regularly moved, how frequently struck? Are the walls raised daily in fair weather? In the warm season, to leeward at night? Is unauthorized material, particularly food, present? In a malarious region do the men have nets, and use them?

Huts: Material; size; shape; cubic capacity; mode of heating; ventilation; lighting; condition of floor; style of bunks; unauthorized material, especially food, present; water-tight or not; dry or damp; ditched and banked; sickness since last inspection; lateral distance between huts; distance to next in rear?

Company street: Is it of proper width; well tamped; ditched; dusty; muddy; well policed? Final disposition of camp waste? How effective?

Kitchen: Cleanliness of ground, tables, utensils. How is food protected before cooking? after? Distance from kitchen sink; distance from nearest part of company street; direction and distance from company sinks; prevailing wind; do flies appear to reach the kitchen from company sink, directly or otherwise? What disposition of waste from kitchen?

Mess-table: If such a table, condition of it and the adjacent ground; are flies there, excepting when meals are served; how are individual utensils cleansed? Is the mess-table screened? If no mess-table, is food eaten at the tents or at the kitchen? If at the tents, are remains of food found there?

Kitchen sink: Character; ultimate disposition of waste; condition of surrounding ground; is it flooded by rain or from ground-water? is it treated with lime or any other disinfectant?

Company sink: Situation as to distance and direction from the nearest company street and company kitchen, with prevailing wind. Character; length; depth; protection from sun, rain, observation?

How frequently and how effectively is earth thrown in? What other disinfectants, if any, introduced? What action is taken against flies, and how frequently? Recommendation. (Such sinks should be covered in and marked before breaking camp, and when their contents approach the level of the surface.)

Camp urinals: How placed in relation to company streets; how arranged; how cared for; are there signs of urination elsewhere?

Food: Variety; amount; regularity of supply; condition when issued; how cooked; waste before or after serving; excess or insufficiency of any particular part of the ration?

Water-supply: How obtained by the men; how is the company supply preserved; if it appears to affect the health of the men, how; if boiling has been ordered, is any drank raw; is there deficiency; is there waste; filtered by or for the company, how and how effectively?

The soldier: Are his uniform and equipment sufficient in amount and character; is there spare underclothing; an extra pair of stockings; do the shoes really fit (the officer should satisfy himself); are the feet in good condition (inspect); if feet not in good condition, fix responsibility and report it; is the person clean; the underclothing clean; hair and beard cropped close; is the canteen occasionally boiled and the inside always kept clean?

For the march: Again inspect the feet; inspect the kit and reject everything not authorized; inspect canteen and allow nothing but pure water (boiled in the tropics), or weak tea, and explain its proper use; inspect for abdominal apron in hot or cold weather; in the tropics require a wet cloth or sponge in the hat; in hot weather authorize outer garments to be well opened when marching in route step or at ease, to facilitate evaporation from the body and to diminish risk of heat exhaustion. At halts, men when fatigued, should be cautioned to lie at full length if the ground permits, or sitting, to lean entirely relaxed against a tree or similar support, and to loosen their belts.

XXXV

APPENDIX

JAPANESE TRAINING IN SANITATION

Because Japan appears to lead the world at this time in applied military sanitation and has made a record for other armies to attain, the training employed therein is summarized as follows from the official *Observations on the Russo-Japanese War*, by Major Charles Lynch, Medical Corps.

The candidate for a commission is given instruction in physiology for two hours a week in the second half of the second year at the local, or preparatory, military school; while serving as a soldier he receives instruction in hygiene from the medical officers; he is further instructed in the sanitation of troops at the Military School; returning to the ranks he learns something further from the regimental medical officers; and should he pass through the Staff College he would have there a six months' advanced course in hygiene. So much for the officers.

The men receive their instruction chiefly from their medical officers and in a slight degree from the line officers, and this is arranged so as sufficiently to inform the soldier how to preserve his health. On occasion this is supplemented by special information, and the duty of maintaining their vigor is made the subject of patriotic appeal. The relation of the officer to the soldier, which is like that of a father to the child, and the constant desire on the part of all to do everything for the common good are particularly favorable to instruction as occasion demands, without nagging or arbitrary interference. "Disobedience of orders is almost unheard of." The authorities in general and the higher commanders in particular fully recognize the importance of good hygiene for the army, the fundamental idea being expressed in this official statement: "Disease greatly decreases fighting capacity and medical [sanitary] instruction of officers and men is quite as important as their instruction in combatant duties," so that there is no necessity to create a sentiment on this subject among those directing the army. The complement of this is found in the calling to account of a commander whose force suffers from disease to what is believed an unwarranted extent, and a soldier who returns home with a preventable disease is made by his friends and his family to realize that he has been a credit neither to his country nor to them.

Other services convinced of its importance may wisely take similar official action in relation to sanitation, but equal results will follow only that patriotic discipline which without oversight executes to the letter sanitary orders as well as other commands, however irksome, because they are for the public good. Until that form of practical patriotism becomes inbred, our soldiers will fail in doing their part and will suffer accordingly.

The conclusion reached is this: "The sanitation of the Japanese army, as has been pointed out, was good. While the responsibility for the recommendations rested upon the Medical Department, it must be recognized that their enforcement depended to a great extent on the line commanders and on the men themselves. The good health of the command as a whole was, therefore, largely dependent on the recognition of the importance of good hygiene to maintain the effectiveness of the army by officers and men generally. That they did recognize this may mainly be ascribed to their thorough practical education on sanitary matters. The responsibility imposed on higher commanders for the health of their forces was also a potent element in securing good hygiene. It should be noted, moreover, that the material of which the army was composed was excellent physically, as it was selected by the medical department only after rigid examination, and physically unfit men were promptly gotten rid of by the same department. The good health of the army, as a whole, was undoubtedly much promoted thereby." (*Med. Obs.*, p. 208)

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