That much foot trouble can be prevented I am convinced, and I am pleased to say that we have in this battalion been able to reduce it to a minimum by taking the following precautions:

1. Secure properly fitting boots.
2. Properly prepare such boots.
3. Anticipate the trouble in the feet themselves and adopt prophylactic treatment.

The service boots, such as are served out, are not wholly satisfactory. They are roughly tried on at no particular time of the day, and in a hard, rough condition.

The correct time to try on such a pair of boots is at the end of a day's work. If they fit properly at this period, it may be taken that they are correct, as far as size is concerned.

The boots are hard and unyielding. They should be well softened before serving out. I find the best softening agent is crude castor oil. Such boots should be immersed in this material for five or six days before giving them to recruits. The stiffest parts, or the parts of the boot most liable to give rise to sores, are just above the heel, the instep, and about the great toe, and such parts should be thoroughly softened before the boot is given to the recruit.

As before stated, marching, properly graduated, is an excellent treatment for flat-foot, coupled with good food and physical drill. It is really astounding how these cases of extreme flat-foot have recovered themselves under this treatment, and I cannot too strongly emphasize this point. A number of men present the conditions of bromidrosis and hyperidrosis, and these are the feet which easily develop sores.

The routine treatment I have adopted for all is as follows:

The socks are washed every second or third day and thoroughly dried, so preventing the accumulation of stale sweat, which is a powerful irritant to the feet.

The feet are washed daily with soap and cold water, carefully dried, and then rubbed with methylated spirit; they are then dusted over with boracic powder.

Before a march the socks are soaped well and dusted with boracic powder.

These prophylactic measures are simple, and perhaps old, but they have answered the purpose so admirably that I have thought it wise to mention them, for in a battalion of over 1,000 strong sore feet have been the exception.

It would seem that some better designed boot could be possible, and I am hoping soon to suggest a pattern whereby certain parts in the structure of the boot may be altered to avoid chafing over the favourite sites.

Marching and Work.

Lastly, I would issue a word of warning against expecting too much at first in the way of marching and work from men of the Territorial Force newly mobilized. Short and easy marches at first, carrying only a portion of their kit, increased gradually while they are becoming accustomed to their new surroundings, are most important points, but very apt to be overlooked.

Beer in moderation and pipe tobacco are far preferable, in these men, to aerated waters and cigarettes. Regular attention to the bowels and a daily shower-bath after a march are most desirable, and the sanitary squad have done much good in assisting in seeing that these have been carried out, and also in explaining to the men the importance of them.

I have left out of this article the hygiene of tents, occurrence of lice, and other complaints which require special treatment, as such is all laid down. What I have tried to set forth is early and prophylactic treatment of Territorials suddenly coming under new conditions—a state new to them, but old to the regular army—and to suggest a few points which I have found by practical experience have been of great service to me as medical officer to this battalion.

It is estimated that in the Franco-Prussian war of 1870-71 rifles were responsible for 90 per cent. of the deaths, artillery for 8 per cent., and the bayonet for 2 per cent. In the Russo-Japanese war, thirty-four years later, the rifle killed fewer—82 per cent., and the gun more—16 per cent. But this does not reach anything like the proportion of the present war, when the chief execution so far has been done by artillery.

INSECTS AND WAR:

LICE.

By A. E. SHIPLEY, Sc.D., F.R.S.,

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LICE form a small group of insects known as the *Anoplura*, interesting to the entomologist because they are now entirely wingless, though it is believed that their ancestry was winged. They are all parasites on vertebrates. In quite recent books the *Anoplura* are described as "lice or disgusting insects, about which little is known," but lately, owing to researches carried on at Cambridge, we have found out something about their habits. As lice play a large part in the minor discomforts of an army, it is worth while considering for a moment what we know about them.

Recently the group has been split up into a large number of genera, but of these only two have any relation to the human body. I do not propose, in the present article, to consider one of these genera—*Phthirus*—which frequents the hairs about the pubic region of man and is conveyed from one human being to another by personal contact. We will confine our attention to the second genus, *Pediculus*, which contains two species parasitic upon man—(*Pediculus capitis*) the hair-lice, and (*Pediculus vestimenti*)

the body-lice. Both of these are extremely difficult to rear in captivity, though in their natural state they abound and multiply to an amazing degree.

Wherever human beings are gathered together in large numbers, with infrequent opportunities of changing their clothes, *P. vestimenti* is sure to spread. It does not arise, as the uncultured think, from dirt, though it flourishes best in dirty surroundings. No *P. vestimenti* occurs that is not the direct product of an egg laid by a mother and fertilized by a

Pediculus vestimenti (Nitzsch). A. Magnified 20 times; B, natural size.

father. In considerable collections of men drawn from the lower classes, some unhappy being or other will turn up in the community with lice on him, and these swiftly spread to others in a manner that will be indicated later on in this article.

Like almost all animals lower than the mammals, the male of the body-lice is smaller than the female. Its body attains a length of about 3 mm., and is about 1 mm. broad. The female is about 3.3 mm. long and about 1.4 mm. broad. It is rather bigger than the hair-lice and its antennae are slightly longer. Its colour is said to vary with the host upon which it lives, and Andrew Murray gives a series of gradations between the black louse of the West African and Australian native, the dark and smoky louse of the Hindu, the orange of the Afriander and of the Hottentot, the yellowish-brown of the Japanese and Chinese, the dark brown of the North and South American Indians, and the paler brown of the Esquimo, which approaches the light dirty-grey colour of the European parasites.

The latter were the forms dealt with in the recent observations undertaken by Mr. C. Warburton in the Quick Laboratory at Cambridge, at the request of the Local Government Board, the authorities of which were anxious to find out whether the flock used in making cheap bedding was instrumental in distributing vermin. Mr. Warburton at once appreciated the fact that he must know the life of the insect before he could successfully attack the problem put before him. He found at an early

stage that *P. vestimenti* survives longer under adverse conditions than *P. capitis*, the head-louse.

The habitat of the body-louse is that side of the under-clothing which is in contact with the body. The louse, which sucks the blood of its host at least twice a day, is when feeding always anchored in the clothes by the claws of one or more of its six legs. Free lice on the skin are rarely found, but the under side of a stripped shirt is often alive with them. After a great many experiments Mr. Warburton succeeded in rearing these delicate insects, but only under certain circumstances, one of which was their anchorage in some sort of flannel or cloth, and the second was proximity to the human skin. He anchored his specimens on small pieces of cloth which he interned in small test tubes plugged with cotton-wool, which did not let the lice out, but did let in air and the emanations of the human body. For fear of breakage the glass tube was enclosed in an outer metal tube, and the whole were kept both night and day in contact with the body. Two meals a day were necessary to keep the lice alive, and to do this the pieces of cloth, which the lice would never let go of, were placed on the back of the hand, hence the danger of escape was practically *nil*, and once placed upon the skin the lice fed immediately and greedily.

This means of keeping lice alive was but the final result of many experiments which had failed. A single female but recently matured was placed in the test tube, and a male admitted to her on the second day. The two paired on the sixth day and afterwards at frequent intervals. Very soon after pairing an egg was laid, and during the remaining twenty-five days of her life the female laid an average of five eggs every twenty-four hours. The male died on the seventeenth day, and a second male was then introduced, who again paired with the female. The latter, however, died on the thirtieth day, and the second male survived.

The difficulty of keeping the male and female alive was simple compared with the difficulty of rearing the eggs. Very few hatched out. The strands upon which they were laid had been carefully removed and placed in separate tubes, at the same time being subjected to different temperatures. It was not, however, until the eggs were left alone undisturbed in the position where they had been laid and placed under the same conditions that the mother lived in, that 8, and only 8, of the 24 eggs laid on the cloth hatched out after an incubation period of eight days. The remaining 16 eggs were apparently dead. But the tube in which they were was transferred to the waistcoat pocket and subjected to normal temperature of the room at night (on occasions this fell below freezing point), and after an incubation period of upwards of a month 6 more hatched out. Hence it is obvious that, as in the case of many other insects, temperature plays a large part in the rate of propagation, and it becomes clear that the eggs or nits of *P. vestimenti* are capable of hatching out up to a period of at least from thirty-five to forty days after they are laid.

Difficult as it was to keep the adults alive, and more difficult as it was to hatch out the eggs, it was most difficult to rear the larvae. Their small size made them difficult to observe, and, like all young animals, they are intolerant of control, much more apt to wander, and less given to clinging to the cloth than their more sedentary parents. Naturally they want to scatter, spread themselves, and pair.

Like young chickens, the larvae feed immediately on emerging from the egg. They apparently moult three times, at an interval of about four days, and on the eleventh day attain their mature form, though they do not pair until four or five days later.

Mr. Warburton summarizes the life-cycle of the insects, as indicated by his experiments, as follows:—

Incubation period: Eight days to five weeks.

From larva to imago: Eleven days.

Non-functional mature condition: Four days.

Adult life: Male, three weeks; female, four weeks.

But we must not forget that these figures are based upon laboratory experiments, and that under the normal conditions the rate may be accelerated. From Mr. Warburton's experiments it is perfectly obvious that, unless regularly fed, body-lice very quickly die. Of all the verminous clothing sent to the Quick Laboratory, very little contained *live* vermin. The newly hatched larvae perish in a day and a half unless they can obtain food.

With regard to the head-louse, it is smaller than the body-louse, and is of a cindery-grey colour. The female measures 1.8 mm. in length and 0.7 in breadth. Like the body-louse, it varies its colour somewhat with the colour of the hair on the different branches of the human race. It lives amongst the hair of the head of people who neglect their heads; it is also, but more rarely, found amongst the eyelashes and in the beard. The egg, which has a certain beauty of symmetry, is cemented to the base of the hair, and at the end of six days the larvae emerge, which, after a certain number of moults, become mature on the eighteenth day. The methods adopted by many natives of plastering their hair with coloured clay, or of anointing it with ointments, probably guards against the presence of these parasites. The Spartan youths, who used to oil their long locks before going into battle, may have feared this parasite. I have been told that the German soldiers before going to war shave their heads. If this is so, they would afford no nidus for *P. capitis*, but, if it is the case, the fact has escaped the lens of the photographers and the pens of the artists. The wigs worn in the late seventeenth and at the beginning of the eighteenth centuries undoubtedly owed something to the difficulty of keeping this particular kind of vermin down.

This article, however, attempts to deal more with the troubles of the camp, and *P. capitis* is in war time less important than *P. vestimenti*. The former certainly causes a certain skin trouble, but the latter not only affords constant irritation, but, like most biting insects, from time to time conveys most serious diseases. *P. vestimenti*, undoubtedly, is the carrier of typhus. This was, I believe, first demonstrated in Algeria, but was amply confirmed last year in Ireland, when a serious outbreak of this fever took place, though little was heard of it in England. Possibly, *P. capitis* also conveys typhus, but undoubtedly both convey certain forms of relapsing or recurrent fever. The irritation due to the body louse weakens the host and prevents sleep, besides which there is psychic disgust which causes many officers to fear lice more than they fear bullets. They are the constant accompaniment of all armies, and in the South African war as soon as a regiment halted they stripped to the skin, turned their clothes inside out, and picked the *Anoplura* off. As a private said to me, "We strips and we picks 'em off and places 'em in the sun, and it kind o' breaks the little beggars' 'earts."

In conjunction with the Quick Professor of Biology at Cambridge I have drawn up the following rules. Most of them will not be possible at all times, but some of them may be possible at some time in the campaign. At any rate, by acting on these rules, a relative of mine who took part in the South African war was able to escape the presence of lice on his body, and the general commanding his regiment told me on his return that he was not only the only officer but the only man in the regiment who had so escaped.

RULES.

1. Search your person as often as possible for signs of the presence of lice—that is, their bites. As soon as these are found, lose no time in taking the measures noted under paragraphs 4 and 5.

2. Try not to sleep where others, especially the unclean, have slept before. Consider this in choosing a camping ground.

3. Change your clothing as often as practicable. After clothes have been discarded for a week the lice are usually dead of starvation. Change clothes at night if possible, and place your clothing away from that of others. Jolting of carts in transport aids in spreading the lice, which also become disseminated by crawling about from one kit to another. Infested clothing and blankets, until dealt with, should be kept apart as far as possible.

4. All discarded clothes, as shirts and vests, should be collected and burnt or buried or put under water. Socks are not so important as body clothing, as lice rarely affect the forearm, the hands, or the feet. Cholera belts were in many cases early discarded in the South African war, owing to infestation of lice.

5. If lice are found on the person they may be readily destroyed by the application of either petrol, paraffin oil, turpentine, xylol, or benzine to the head in the case of *P. capitis*. The application may be repeated on two or more days if the infestation is heavy. Fine combs are useful in detecting and removing vermin from the head. Tobacco extract has been advocated, failing other

available remedies. In the case of *P. vestimenti* the lice can be killed as follows: Underclothes may be scalded, say, once in ten days. Turn coats, waistcoats, trousers, etc., inside out, examine beneath the folds at the seams and expose these places to as much heat as can be borne before a fire, against a boiler, or allow a jet of steam from a kettle or boiler to travel especially along the seams. The clothing will soon dry. If available, a hot flat-iron may be used to kill vermin in clothing. Petrol or paraffin will also kill nits and lice in clothing.

6. As far as possible avoid scratching the irritated part.

7. Privates would benefit by instruction in these matters.

8. Apart from the physical discomfort and loss of sleep induced by the attacks of lice, it should be noted that they have been shown to be the carriers of typhus and relapsing fever from infected to healthy persons. Typhus, especially, has played havoc in the past, and has been a dread accompaniment of war.

EIGHTY-SECOND ANNUAL MEETING

OF THE

British Medical Association.

PROCEEDINGS OF SECTIONS.

SECTION OF ANATOMY AND PHYSIOLOGY.

ROBERT W. REID, M.D., President.

CARDIAC FIBRILLATION AND ITS RELATION TO CHLOROFORM ANAESTHESIA.

By J. A. MACWILLIAM, M.D.,

Professor of Physiology in the University of Aberdeen.

So long ago as 1887 I advanced the view that many cases of sudden death depending on cardiac failure are due to the sudden occurrence of fibrillation in the ventricles, the function of the cardiac pump being thus destroyed. Evidence was adduced to show the inadequacy of the current view of syncope to account for the facts in many instances of sudden dissolution, by the assumption of a sudden failure of the heart to contract, and the strong probability of the true cause lying, not in an abrupt enfeeblement or paralysis of the contractile power, but in the superposition of the useless and disastrous form of inco-ordinated activity known as "fibrillar contraction" or "fibrillation." In a paper in the *BRITISH MEDICAL JOURNAL* I urged the probability of this explanation as applying to various conditions in which sudden death occurs.⁵ But the gulf between experimental physiology and practical medicine in this branch of study was vastly wider then than it is now, thanks, above all, to the labours of James Mackenzie and his followers. In recent years the view I propounded in 1887 has been adopted by Gibson, Mackenzie, and others, and evidence corroborating it has been brought forward by Hering.¹

Former Observations.

At the time of my old papers, and for some years afterwards, the central question in regard to chloroform was that of respiratory failure *versus* primary cardiac failure, or rather the possible occurrence of primary cardiac failure, it being admitted that respiratory failure is the usual one when chloroform is steadily pushed to a toxic stage. My conclusion was an emphatic affirmation of the occurrence of primary cardiac failure as a form of chloroform collapse, in opposition to the conclusions of the Hyderabad Commission and other observers. Fibrillation had often been noted in the course of my experiments, especially as a result of the sudden intake of strong chloroform vapour, but I was not at that time satisfied as to its occurring in the absence of at least a temporarily excessive intake of chloroform. There was no evidence to warrant the assumption that such a mode of cardiac failure was an operative one in the administration of chloroform in the ordinary way in healthy animals, meaning by the latter phrase the *continuous* administration of the anaesthetic by the animal being put in a box*

* Analyses recently made by Mr. E. S. Edie of the air in the box as regards O and CO₂ at the end of the induction of anaesthesia showed quite trivial differences.

with chloroform, and allowed to inhale the vapour until complete anaesthesia is induced.

That with such continuous administration there is immunity from collapse due to fibrillation is a conclusion I wish to reaffirm to-day in view of experience spread over nearly thirty years. But when one comes to review the results of irregular or intermittent administration a very different tale has to be told—a tale of trouble and disaster that in the case of laboratory experimentation has given chloroform a bad reputation as compared with other anaesthetic agents, and has led to its falling into comparative disuse.

Further Evidence.

In the course of the last twenty years we have in this laboratory had entirely conclusive evidence of the liability to cardiac failure of this sort, especially in cats, in what is clearly a condition of light anaesthesia, while the conjunctival reflex may be distinctly present, and a tendency to reflex movements in response to afferent impulses very marked. In a series of sixteen cats, examined a year or two ago in conjunction with Dr. G. Spencer Melvin, intermittent administration of chloroform was employed, and collapse clearly due to fibrillation occurred in nine of the sixteen animals.

It is clear that in the case of the ordinary (healthy) laboratory animals, and especially in the cat, the exclusion of collapse from ventricular fibrillation would render chloroform, when used with reasonable care, a safe anaesthetic.

It is perfectly practicable to readminister chloroform again and again, using due care, without inducing fibrillation, while a sudden readministration or a sudden increase in the strength of the vapour inhaled during the sensitive stage may readily induce collapse from fibrillation. In this respect the use of mixtures of air and chloroform of known strength offers obvious advantages.

In some exceptional instances (cats) so excessively sensitive a cardiac condition may be developed, after lightening of the original anaesthesia, that recommencement of the inhalation of even low percentages of chloroform is apt to be attended by the speedy occurrence of fibrillation.

It may be noted that the hypodermic administration of such drugs as omopon and chloral, while assisting the development of anaesthesia, do not afford any protection against chloroform fibrillation, if they do not, indeed, make the heart more prone to fibrillate; in any case, they tend towards the prolongation of the stage of insufficient chloroform which is associated with the liability to fibrillation.

Some Relations of Ventricular Fibrillation.

Ventricular fibrillation may occur at two phases of the action of chloroform: (1) In the early stage, this being by far the more common case; or (2) at a very advanced stage of the toxic action of the drug when the heart is greatly enfeebled and dilated. In some kinds of animals fibrillation may occur with great regularity as soon as the chloroform is pushed to a certain extent, weakening and dilating the heart.

Dilatation of the heart is not necessarily protective against the onset of fibrillation. Dilatation depends on diminished contraction—force and tone, while insensitiveness to fibrillation depends solely on a quite distinct condition—depression of excitability—which may or may not be associated with dilatation. Enfeeblement and diminution of tone are certainly often associated with dulling of excitability, but not necessarily so. There are cases of diminished sensibility associated with no sign of dilatation, and, on the other hand, marked proneness to fibrillation with marked dilatation.

The special incidence of chloroform fibrillation on the ventricles as compared with the auricles is noteworthy. The latter commonly preserve their rhythmic action, though they sometimes may fibrillate also.

There are some animals that seem to be specially liable to fibrillation under chloroform. In them we have very often found great resistance to the induction of anaesthesia, a very large amount of chloroform being required; during the induction marked excitability and tendency to struggle, quick irregular pulse, high blood pressure and defective vagus control over the heart. The complex and striking irregularity of the heart beat in cats in the earlier phases of chloroform administration attracted my attention very many years ago, and are mentioned in