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Notified in Army Orders for January 1947

THE WAR OFFICE

Memoranda on

Medical Diseases in Tropical and Sub-Tropical Areas

Eighth Edition
1946

LONDON: HIS MAJESTY'S STATIONERY OFFICE
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PREFACE

These Memoranda were originally compiled by the late Sir Andrew Balfour, K.C.M.G., C.B., F.R.S., for medical officers serving abroad in the war of 1914-18. He and his collaborators prepared two further editions and the work continued to expand under the editorship of Lieutenant-General Sir William MacArthur, K.C.B., D.S.O., O.B.E. This, the eighth, edition contains new articles on Infective Hepatitis, Leprosy, Nutritional Diseases, Sulphonamide Drugs, Tropical Eosinophilia, and Uses of D.D.T., while the formerly separate sections on Kala-azar and Oriental sore (Cutaneous leishmaniasis) have been brought together under the single heading : Leishmaniasis. In the same way, the section on Amœbiasis includes Intestinal amœbiasis (Amœbic dysentery) and Hepatic amœbiasis (Hepatic abscess).

Many sections have been wholly or largely rewritten to bring them into line with the numerous and rapid advances in our knowledge during the 1939-45 war, and 20 new figures or plates have been added or substituted. Many of the illustrations have been lent by the Wellcome Bureau of Scientific Research.

Like its predecessors this book does not claim to be more than a series of miscellaneous memoranda arranged in alphabetical order. It has been suggested that the volume could easily be expanded into a text-book, and some day this may be undertaken. But our present aim has been to give medical officers something that can be more easily carried around than a text-book and yet offer in concise form the essentials of the more important diseases of the tropics. This volume is intended as a companion, not as a rival, to standard works.

The task of producing a new edition has been helped forward in different ways by many friends of the War Office, and by the useful suggestions offered by reviewers who took notice of the seventh (1942) edition. We have not met all the points brought to our notice ; therefore we cannot hope to have pleased everyone, but we are fully conscious of our responsibilities to a growing number of readers and friends, to all of whom we owe and gladly offer our best thanks.

Alex. Hood.

Lieutenant-General,
Director-General,
Army Medical Services.

10th July, 1946.

ANCYLOSTOMIASIS

This important helminthic infection prevails wherever climatic conditions and imperfect sanitation permit the development of ancylostomes. The disease is widely distributed between the latitudes of 30 deg. N. and 30 deg. S., and beyond these limits it has been found among workers in mines and tunnels, owing to the higher temperature in such places, and the lack of sanitary control.

Etiology.—Human ancylostomiasis is due mainly to two species of nematode worms belonging to different genera of the family Acylostomidæ. One of these species is *Ancylostoma duodenale*, the other *Necator americanus*. Their respective distribution is difficult to demarcate as they have often been confused in the past. In most affected countries both species occur, and they may be present in the same person. Other factors being equal, *A. duodenale* appears to be more hurtful to its host than *N. americanus*. *A. braziliense*, *A. caninum* and *A. malayanum*, ancylostomes normally parasitic on animals, occasionally invade man, giving rise to a creeping eruption of the skin. But these animal ancylostomes do not undergo further development in the human host ; therefore visceral symptoms do not follow.

The ancylostomes are small worms, about 8–10 mm. long, of a pinkish-white colour when alive, but grey when dead. When gorged with blood they are reddish brown. Male and female forms are present and their habitat is the human small intestine, more especially the jejunum, though they are also found in the duodenum and rarely in the ileum. Ancylostomes attach themselves to the mucous membrane by means of their buccal armature, more formidable in the case of *A. duodenale*. Its mouth capsule possesses both dorsal and ventral hooked teeth, while in *N. americanus* the solitary so-called "tooth" is dorsal. The latter has the teeth proper replaced by chitinous plates. Each species is also armed with internal buccal lancets.

In *A. braziliense*, the outer pair of ventral teeth are large and well developed, whereas the inner pair are minute.

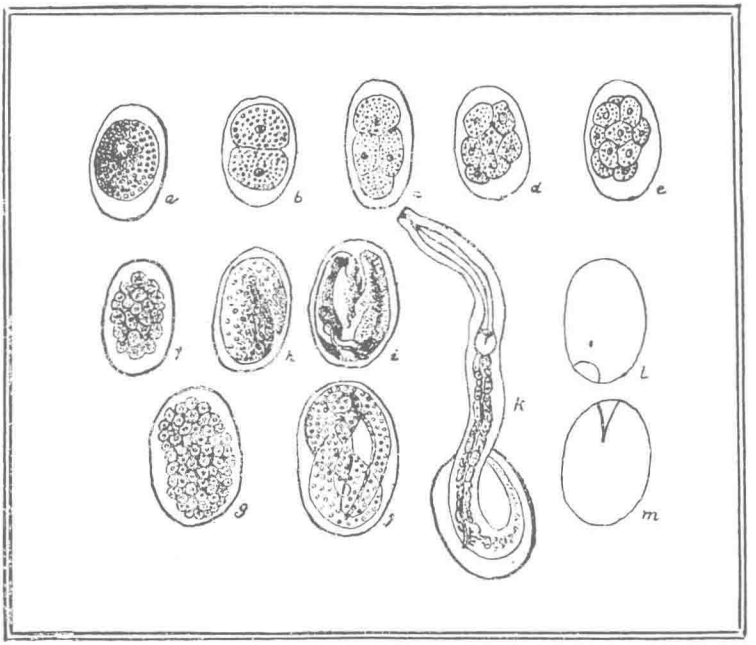
These worms are blood-sucking parasites, and the symptoms they produce are due in part to loss of blood, in part doubtless to the slow destruction of the mucosa and submucosa on which the ancylostomes feed, and possibly also to the effects of a hæmolytic toxin which they are believed to excrete. It has also been said that bacterial infections may result through the lesions caused by the parasites and that these play an important part in the symptomatology.

A certain amount of development occurs as the egg travels down the human alimentary canal, for the contained granular mass divides into two and then into four segments. It is at this latter stage that the egg is usually found in the fæces (Plate 1).

Air, moisture, and heat are required for further development, which is most rapid when the temperature is at 25 deg. to 35 deg. C. (77 deg. to 95 deg. F.). In twenty-four hours, if the conditions are favourable, the

young embryo can be seen coiled up in the egg. It escapes from it as a larva in from two to seven days and feeds upon the fæces (Fig. 1). The larva moults twice, and often after the second moult it retains the cast skin as a sheath, but this may be discarded. It has now reached the infective stage and, ceasing to feed and grow, it makes for moist earth or water. It is active and can swim, wriggle, and even climb up any surface which is wet, and it is greatly assisted in its progression by the presence

Fig. 1.



Development of *Ancylostoma duodenale*: *a*, *b*, *c*, *d*, *e*, *f*, *g*, segmentation of egg; *h*, *i*, *j*, the larva; *k*, escape of larva from egg; *l*, *m*, empty egg-shell. Greatly enlarged. (After Perroncito.)

of an accompanying film of water. Larvæ may pass vertically through as much as thirty-six inches of light soil to reach the surface of the ground, but their radial spread from a focus of infection seems to be limited to a few inches.

Infection can take place in two ways, through the mouth and through the skin. The latter is much the more important, though direct transference through the mouth may occur as in the case of infected drinking water, food, especially vegetables, or food vessels contaminated by mud containing the larvæ and amongst earth-eaters or children who carry dirt to their mouths. The skin route is by way of the hair follicles through which the larvæ pass, and from the subcutaneous tissues they reach the veins and lymphatics and travel to the intestine via the heart, arteries, capillaries, and air cells of the lung, bronchi, trachea, larynx, œsophagus and stomach. Leaving the stomach, they mature in the intestine, and,

after copulation, the female produces eggs which appear in the fæces seven to ten weeks after infection. There is evidence to show than an alternative route from the lungs is also, though more rarely, followed, namely, by the pulmonary artery to the pulmonary veins and in the general blood stream to the jejunum, where the mucosa is pierced and the larvæ reach the lumen of the bowel.

The adult worms may remain alive in the intestine, in diminishing numbers, for as long as six years.

Symptoms.—As the ancylostomes present vary greatly in numbers the symptoms naturally also vary in different cases. Other factors in variability are personal idiosyncrasy and the presence of associated diseases. In the main the symptomatology is that of a secondary anæmia. Recent studies have shown the importance of a deficient diet in the production of this anæmia.

There are cryptic, mild, and severe types. In the first variety the disease can only be definitely diagnosed by the finding of ova in the stools. Such cases are rather ancylostome carriers than victims of ancylostomiasis, but careful inquiry will often show some slight digestive trouble with tenderness and pain and discomfort in the epigastrium. There may be a slight reduction in the hæmoglobin content of the blood and a trifling loss in the power of mental concentration. It may be said of such cases that they do not know they have been ill until they are cured. They notice the difference in their health when freed from their worms. A blood examination may reveal eosinophilia and suggest an examination of the fæces. It has been stated that 500 worms must be present for six months before effects are produced on the host.

The mild cases present moderate anæmia, and epigastric tenderness is a marked feature often associated with acid dyspepsia. The ingestion of food frequently, if temporarily, relieves the painful sensations. Palpitation, tachycardia, pulsation of neck veins, and a low systolic blood pressure are among the commonest cardio-vascular symptoms. Cough and bronchitis may occur, due possibly to passage of the larvæ through the lungs.

Severe cases show a disordered or depraved appetite. It is often ravenous, and a craving for earth is common. The patient becomes pot-bellied, his stomach may be dilated and he is usually constipated. Rarely there is blood in the stools mixed up with the fæces.

Physical and mental fatigue ensue, together with various nervous symptoms and joint pains. As the anæmia progresses the palpitation and dyspnœa increase. In marked cases the red cell count may be as low as 2 million per c.mm. with a hæmoglobin of 20 per cent. Œdema shows itself in advanced cases chiefly about the face and ankles; a puffy face is not uncommon and ascites may occur. The patient rather resembles a man suffering from chronic nephritis. In white patients the skin, which is dry, assumes an earthy hue, and attention has been drawn to the peculiar dead-white appearance of the conjunctiva of the lower lid, and to the pale flabby tongue which has been likened to white blotting-paper.

It is important to note that ancylostomiasis may apparently be a cause of jaundice and of liver enlargement. There is no change in the spleen.

Emaciation is not a feature of the disease in adults. Stunting, both mental and physical, is common in children with severe parasitization. Faulty nutrition is usually an important factor in these cases.

So much for the general symptoms. In the tropics anæmia plus dropsy should always lead one to think of ancylostomiasis. As regards the skin eruption at the site of invasion, it suffices to say that at the start it is a mild dermatitis characterized by redness and the presence of urticarial weals or small vesicles, and that later, owing to secondary pyogenic infection, it assumes a pustular character. It is known as ground-itch. It should be noted that the skin invasion by *A. duodenale* does not always give rise to dermatitis and that ground-itch is not common in Egypt where ancylostomiasis is rife.

Complications.—Ulceration of the mouth may be noted. The disease often occurs along with malaria and amœbic dysentery.

Diagnosis.—This can only be made with certainty by the discovery of ova in the fæces, though it must be remembered that their absence does not exclude ancylostomiasis, for symptoms may persist though the parasites have disappeared spontaneously or have been expelled. If ova are not found on direct examination and if the more elaborate concentration methods, such as that of Clayton Lane, are not feasible, it is not a bad plan to place washed and sedimented fæces on a slide for a few minutes and then gently immerse in water. The ova remain after everything else has been washed off, and by repeating the process quite a collection of eggs may be obtained on the slide.

The eggs of such nematodes as *Trichostrongylus colubriformis* and *Ternidens deminutus*, which occasionally parasitize man, may readily be mistaken for those of ancylostomes. In doubtful cases a series of eggs should be measured, and the degree of development in the yolk of freshly passed specimens carefully noted.

Eosinophilia is often present but it is not sufficiently characteristic of the disease to be of much diagnostic value. It is often absent in severe infections and when the hookworm disease is complicated by malaria or kala-azar.

Differential Diagnosis.—Distinguish from Bright's disease, beriberi, and secondary anæmia from other causes.

Prophylaxis.—From what has been said it must be evident that the chief prophylactic measure consists in preventing the fæcal contamination of soil, water, or such foodstuffs as vegetables which are eaten uncooked. Special care as regards conservancy methods in the tropics is therefore of prime importance.

The employment of the deep bore-hole latrine affords an adequate method for disposal of fæces, and is preferable to trenching systems. In either case care must be taken to see that the edges of surfaces around the latrine openings are kept clean and that the feet of users are protected.

Bucket-removal systems are less satisfactory but may have to be employed under certain circumstances. Cresol should be placed in the latrine buckets in the usual way or, if this is not available, a layer of common salt on the bottom of the bucket and another on the top when

the bucket is full, will serve the same purpose. In the latter case intimate contact with the fæces must be ensured by mixing, as solid salt does not penetrate fæces for some forty-eight hours.

If incineration is employed there must be no mixing of the fresh fæces with bhoosa or other combustible matter on the ground, thereby increasing the risk of soil contamination. From the pan to the fire must be the motto.

Contaminated soil is the most important source of infection, and such contamination may be direct or indirect, the latter often occurring owing to dissemination by footwear. Over three hundred larvæ have been recovered from the muddy shoes of one person. Ova, too, may pass unaffected through the stomach and intestine of the domestic pig and may be disseminated in this way.

Camping sites must be carefully selected and kept clean. Contamination of ground may be established by the finding of larvæ and an apparatus for their detection has been devised. It consists of a funnel covered by a fine mesh sieve in which the soil is placed. When the funnel is filled with water up to the lower soil level the larvæ pass into the water and can be recovered from the lower end of the funnel.

Badly contaminated ground should be abandoned, but as most of the larvæ are found near the surface of the ground and are usually localized in their lateral distribution, less seriously affected areas may be treated by digging up to a depth of eighteen inches and applying 2 per cent. boiling cresol solution or an 8 per cent. solution of common salt. If these measures are impossible the suspected ground may be "fired" before use.

Owing to the need of the larvæ for moisture the drying up of damp areas by drainage often achieves good results.

Water supplies should be protected and bathing places properly chosen and regulated, while all measures necessary must be taken to prevent contamination of foodstuffs such as vegetables and fruits which are eaten uncooked. As a further protection all uncooked fruit and vegetables should be thoroughly washed before eating. Hands should also be thoroughly washed with soap and water before, and preferably also after, all meals.

Great importance is attached to the effective purification of water supplies, especially by filtration.

The protection of the individual must be given careful consideration. Boots and sandals, if not defective, protect to a great extent, but it must be remembered that when not on the march native troops may discard their boots and in this way convey infection.

Many Indian and African troops already suffer from mild degrees of the disease or at least harbour parasites.

In Egypt about half the rural population are infested, the infestation-rate being as high as 90 per cent. in some villages. But the intensity of the parasitization is low compared with its prevalence.

In civil communities an important prophylactic measure is the freeing of carrier cases and of those who suffer from ancylostomiasis from their parasites, in other words, the extermination of the mature worm; but this cannot be done on a large scale in the case of a field force.

Treatment.—The cheapest and safest anthelmintic in the treatment of ancylostomiasis is tetrachlorethylene, which may be given in a single dose of 4 c.cm. The addition of 1 c.cm. of oil of chenopodium renders the mixture more effective. The drug is best administered in the early morning on an empty stomach. No food should be given until there is a satisfactory bowel movement. A dose of Epsom salts may be given if the bowels do not act within four hours. In markedly anæmic and debilitated persons it is usually advisable to treat the anæmia with massive iron therapy before starting the anthelmintic.

Tetrachlorethylene is also effective against *Enterobius*, but not against *Trichuris*.

Carbon tetrachloride is also an effective anthelmintic, but its use is not free from danger.

Fatalities have followed the administration of impure preparations, but the drug, even when certified by reliable chemists to be free from contamination, has caused death, presumably by acting on a liver already diseased. Therefore carbon tetrachloride should never be used for treating known alcoholics. In poisonous doses, carbon tetrachloride causes a central lobular necrosis of the liver with fatty degeneration which may begin even within four hours of administration. The clinical evidences of poisoning are vomiting, liver tenderness and pain, jaundice, hæmaturia, and temporary suppression of urine. Treatment consists in the administration of glucose, either intravenously in a 5 per cent. solution, of which several hundred c.cm. may be given, or in drachm doses by the mouth.

0·2 c.cm. of carbon tetrachloride, in gelatine capsules, in water, or emulsified in skimmed milk, may be given for each year of age up to a maximum of 4 c.cm., the ordinary dose for an adult being 3 c.cm. This is usually administered early in the morning, the patient taking no breakfast that day. The drug may act as its own purge, but it is advisable to follow the carbon tetrachloride by a dose of magnesium sulphate about three hours later. This may prevent headache, giddiness, and other unpleasant symptoms. Food should be withheld until the purgative has acted freely.

Carbon tetrachloride is very effective for threadworms, and is of some value in *Ascaris* infection; it is useless against *Trichuris*, *Strongyloides*, and tapeworm.

Oil of chenopodium has been used with success in many ancylostome campaigns. The medicinal properties of this drug depend on the contained ascaridol, but the chemical composition of the oil is not constant, so that a dose recommended as the optimum for treatment may not always give equally satisfactory results.

Oil of chenopodium is best given in gelatine capsules filled a few hours before use, or it may be taken in emulsion or in water. Some prefer to administer the dose on an empty stomach, the patient taking no food on the morning of the treatment. Others hold that full diet lessens the toxicity of the drug and does not lessen its efficacy. The maximum dose is 3 c.cm., but smaller amounts are usually administered. Excellent results have been obtained by three 0·5 c.cm. doses given at intervals of an hour, and followed by a dose of magnesium sulphate about two hours later. Two such treatments have been claimed to remove 99 per cent. of

worms. Another method is to give the oil in one single dose of 2 c.cm., followed by a saline purge as before.

Oil of chenopodium is effective against *Ascaris* and *Strongyloides*.

Narcosis and other ill-effects have followed the administration of the oil and cumulative effects have been noted, so it must be given with care, especially in debilitated persons. The treatment should not be repeated under ten days. There is no chemical antidote. In cases of poisoning digitalis and adrenaline have been found useful. Caffeine does harm.

Oil of chenopodium may be combined with carbon tetrachloride, one part of the former to two of the latter. 0·1 c.cm. of the mixture is given for each year of age up to 1·5 c.cm. The dose is divided into two equal parts taken in water at an interval of one or two hours. Two hours after the second dose a saline purge is given.

Hexylresorcinol, prescribed in gelatine capsules, has been recommended, especially in the case of critically ill patients, as it is less toxic than carbon tetrachloride. The adult dose is five pills, each containing 3 grains, taken in one dose. No food should be allowed for at least four hours after taking the drug. A saline purge should be given twenty-four hours later.

Remember that the passage of worms after anthelmintic treatment is an indication for continuing rather than stopping treatment. Cessation of treatment should depend on the disappearance of symptoms and the negative results of later microscopical examinations.

The anæmia must be treated by iron and other tonics; a nutritious and easily assimilable diet should be prescribed.

Ground-itch is best treated by an ointment containing zinc oxide and salicylic acid. Bad cases may require antiseptic dressings.

SOME
ARTHROPOD PESTS*
WINGLESS PESTS

Under this heading the following arthropods are included :—Lice, Bugs, Fleas, the Itch Mite, Ticks and Ants.

LICE

The lice comprise two groups of insects :—

1. The biting or feather lice (*Mallophaga*), which live on the skin of birds and of certain non-human mammals. Their mouth parts are adapted for biting solid objects.
2. The sucking lice (*Anoplura*), of which only one family, *Pediculidæ*, infests man and monkeys. The members of this group have eyes and this distinguishes them from all other *Anoplura*.

Animals which are closely related tend to have similar or identical lice.

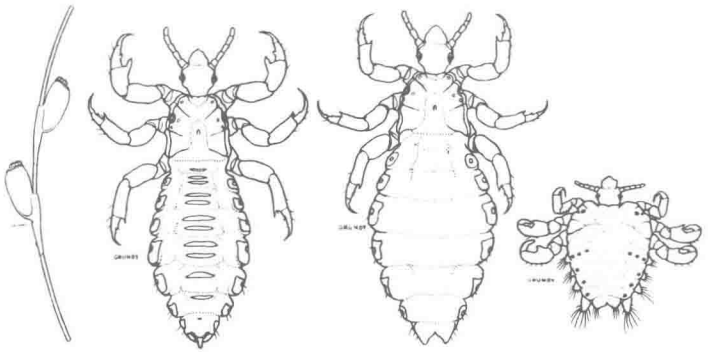
* Some of the drawings illustrating this section are reproduced by permission of the Wellcome Bureau of Scientific Research. Others were drawn from life by John Hull Grundy.

The family *Pediculidæ* comprises three genera : *Pedicinus*, *Pediculus*, and *Phthirus*. Of these, *Pedicinus* is found only on monkeys; *Pediculus* and *Phthirus* infest only man and the higher apes—they do not infest other monkeys.

The sucking lice are markedly host-specific, living only on one host or on a few that are closely related. They are also obligate parasites, living their whole lives on the skin of their chosen mammal. As far as we know, they have few enemies in nature. They can harbour the spirochætes of relapsing fever and the rickettsiæ of typhus and trench fever.

The genera of which man is the natural host comprise two species, *Pediculus humanus* (head and body lice) and *Phthirus pubis* (crab lice) (Fig. 2). Head lice and body lice are now regarded as varieties of *Pediculus humanus*, and not as two distinct species. Consequently, if it is desired to separate these two sub-species a trinominal designation is necessary, for a binominal label is the badge of a species.

Fig. 2.



Nits on hair. Body louse female. Body louse male. Crab louse female.

Usually *P. humanus capitis* and *P. humanus corporis* can be distinguished by slight morphological differences. The more slender antennal segments of the body louse may be mentioned as probably the most obvious of these. The third antennal segment of a body louse can be seen at a glance to be definitely longer than it is broad, whereas in a head louse the broadest part of this segment is not strikingly less than the length. Head lice are usually somewhat smaller and more deeply pigmented than body lice; indentations between their successive abdominal segments are also deeper and more clearly marked, and their legs are somewhat shorter. These variable factors are useful enough as generalizations but of little diagnostic value in any particular case.

Biological differences are of more importance. Head lice attach their eggs to hair whereas body lice attach them to the inner side of clothing in close contact with the body. On account of their environmental conditions, head lice are more active at low temperatures than body lice ; but the distinction between the two is far from sharp. Head lice may often be found on the body ; less often body lice are found on the head. It may be assumed that a certain amount of inter-breeding takes place ; this

would account for individuals with features common to both. It has been asserted that lice from Europeans, Africans, Chinese, and other races show slight and inconstant differences, and that lice which infest dark skins are themselves more pigmented than those from fair skins.

Diseases transmitted by lice.—Epidemic typhus, epidemic relapsing fever, and trench fever. Lice cause considerable cutaneous irritation, and as a result of scratching, secondary infection may occur, and diseases such as impetigo, infective dermatitis, and furunculosis may develop in infested persons. Until these complications develop, general symptoms of toxæmia due to the actual infestation are not usually noted, but if a patient is very heavily infested, general symptoms of a toxic nature may be seen : there is usually a slight but persistent rise of temperature, headache, lethargy, and pains in the joints, and a rash resembling german measles may appear. These symptoms disappear when the patient is deloused.

As far as we know, the crab louse (*Phthirus pubis*) transmits no specific disease ; but it irritates the skin, and the consequent scratching leads to infection.

Pediculus humanus corporis

Under ideal conditions the female body louse may lay 10 eggs a day, and a total number of about 300 in the course of her life. Egg-laying is most active at a temperature of 30° C. (88° F.) and ceases at 20° C. (68° F.). If kept at body temperature (37° C.) the eggs hatch in about six days ; at temperatures above 37° C. (98·6° F.) eggs do not develop, and are killed if a temperature of 40° C. (104° F.) is maintained. Under cold conditions eggs are killed in two hours at a temperature of—17° C. (1·4° F.), and in seven days at a temperature of 5° C. (41° F.). If maintained at a temperature of 22° C. (72° F.) ova do not hatch. The development of the ova may be retarded by variations of temperature and if infested clothing is not worn frequently the hatching may be delayed for as long as 25 days.

The larva which emerges from the egg has a general resemblance to the adult ; three moults occur before the adult males and females are formed.

Buxton gives the following data, in which the time-periods are adjusted to allow for fluctuations in temperature, with consequent retardation of development :—

> The egg stage lasts nine days and 30 per cent. of the eggs fail to hatch. The larval stage lasts for nine days and the mortality may be 40 per cent. The female lives for 34 days ; she does not lay eggs on the 1st, 2nd or 34th day, but she may lay nine eggs a day from the third to the thirty-third day inclusive, *i.e.* a total of 279 eggs. Therefore, allowing for the mortality of eggs and larvæ, 100 eggs produce 42 adults.

The geographical distribution of lice is very wide, and there is no part of the world in which the insect (either *corporis* or *capitis*) cannot be found, except for a few localized areas where the inhabitants have maintained a high standard of personal hygiene. At ordinary room temperatures (*e.g.* 16° C., 61° F.) in temperate climates they can exist without feeding for a week, but in warmer climates their life is shortened and at temperatures of 30° C. (86° F.) they usually die in two days if removed

from their host. Infestations can therefore easily arise from sleeping on straw or blankets where a lousy individual has slept a few days previously. It is important to remember that fluctuations in temperature retard the development of the eggs and that, even in a temperate climate, eggs on clothing may remain a possible source of infestation for about 25–30 days, which is approximately the limit of life in the egg.

Severe infestations readily occur in those who have to wear their clothes continuously. It should be noted that lice tend to leave their host if he has a fever or if his temperature falls at death, and thereby epidemics of louse-borne diseases may occur.

Examination for lice.—Persons harbouring body lice usually have scratch marks scattered on the body, particularly on the shoulders and waist. The actual bites of the insect may be seen as tiny punctures with an encircling area of erythema ; the clothes should be carefully searched, particularly the under-garments, with special attention to the seams and folds, for it is here that the eggs will be found. Sometimes body lice may be found on the skin and in the bedding of infested persons. The eggs are the size of a pin's head (0·8 mm. long by 0·3 mm. broad), yellowish white in colour, goblet-shaped, and firmly attached at the lower end to the cloth fibre by a cement secreted by the female at the time of laying.

Lice are very susceptible to rises or falls of temperature and will readily leave a typhus patient with high fever ; as a result there may be a few adult lice but many nits on his clothing. Lice may be passed from person to person by close personal contact as in the case of troops on active service or refugees huddled together for warmth.

Lice may pass from their host on to chairs or bedding, and they may become airborne, especially the younger forms, when infested bedding and clothing is handled or shaken. Therefore in making an examination be careful to stand to windward of the clothes and person examined.

Preventive Measures

1. Sources of infestation should be avoided ; this is very important and soldiers should be discouraged from mixing with an infested local population, particularly if typhus is prevalent.

2. Frequent bathing and washing of clothes will remove adult lice that may be picked up. At least one hot bath and one change of underclothing should be provided each week, if possible.

3. If conditions favour infestation, and bathing and laundry facilities are poor, it is desirable to issue an anti-louse powder. The best is 10 per cent. D.D.T. in some inert powder such as kaolin. The amount required is about $\frac{3}{4}$ oz. a person a week ; the individual himself sprinkles the powder on the clothing and rubs it into the seams.

4. Clothing impregnated with a persistent insecticide such as D.D.T. gives almost complete protection. This is the principle of "anti-typhus" shirts (shirts A/T).

5. Self-inspection is important if conditions favour lousiness. Underclothing should be carefully looked over each time it is removed.

6. Every soldier joining a new unit should be inspected to ensure that he is not introducing lice.