

In 8% of the cases inoperability was due to the poor general condition of the patient, and in 32% to the advanced state of the growth.

With regard to age, operability was greatest between 40 and 49, and declined in patients older or younger than this.

Inoperability of the carcinoma itself was determined by the presence of one or more of the following conditions: local fixation of the growth, hepatic metastases, peritoneal carcinomatous plaques, or extensive involvement of the abdominal lymph glands. Laparotomy was usually necessary to decide on the existence of these contraindications.

Local fixity of the growth was noted in 23.9% of the generally operable cases, and in 18.9% of the cases that had laparotomy performed. The fixation was usually in front to the related pelvic or abdominal viscera. Growths involving the anterior wall of the rectum were much less frequently operable than those confined to the other quadrants of the bowel. The operability of anterior growths in women was higher than in men. The adhesions producing fixation were usually, but not invariably, inflammatory in character.

Hepatic metastases were palpable in 11.5% of the cases proceeding to laparotomy. The presence of concealed undetected metastases is postulated in another 14.3% of these cases.

Nodules of growth in the peritoneum or extensive involvement of the abdominal lymph glands were noted in 11.1% of cases submitted to laparotomy. These conditions, however, were seldom the sole cause of inoperability.

In endeavouring to secure a high operability rate the importance of having available several radical procedures of varying severity is stressed.

The operative mortality rate for all operable cases having some form of surgical treatment was 15.6%, for cases submitted to combined excision 18.7%, and for those submitted to perineal excision 7.9%.

I wish to express my thanks to the honorary staff of St. Mark's Hospital for permission to undertake this analysis of their cases, to Mr. H. J. R. Bussey for preparing the photographs of specimens and drawings, and to Mr. W. B. Gabriel and Dr. Cuthbert Dukes for their interest, criticism, and advice.

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## THE PARASITOLOGY OF SCABIES

BY

Professor P. A. BUXTON

*London School of Hygiene and Tropical Medicine*

It seems clear that scabies is increasing among civilians and soldiers. This has resulted in so many people inquiring for details of the life history of the itch mite that I venture to publish this account of what is at present known. I have not dealt with the methods of treating the patient or killing the mite, for it is believed that a summary of that side of the subject is in active preparation by other hands.

The correct name of the mite which causes scabies is *Sarcoptes scabiei* de Geer. There are a number of races which occur on different animals (see below), and that on man is known as var. *hominis*.

### Appearance

The dorsal surface of the adult female itch mite is shown in Fig. 1. The figure is drawn from a specimen from the horse, but this variety is not distinguishable in structure from that occurring in human beings.

The general outline of the itch mite is oval: it is convex above and flat below, and of a dirty white colour, except the brownish bases of legs, etc. The body is divided into two regions by a constriction between the two anterior and two posterior pairs of legs. The greater part of the surface, dorsal and ventral, is covered with fine transverse folds, which are characteristic of *Sarcoptes* (and of certain related genera of itch mites which occur on domestic animals but not on man); the upper surface bears a number of specialized spines and conical scales.

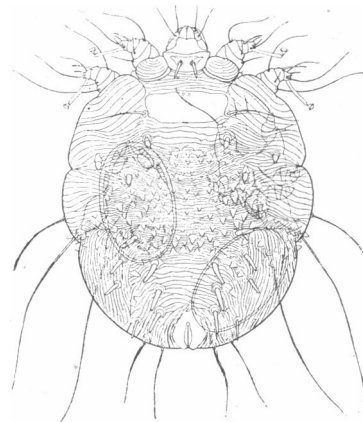


FIG. 1.—Dorsal surface of adult female *S. scabiei* var. *equi*.  
(From Hirst, 1922.)

The anus is terminal. The legs are short; in the female the first and second legs terminate in suckers (ambulacra) carried on the ends of unjointed stalks; in the male there are similar suckers on the first, second, and fourth legs. The male also differs from the female in the large and elaborate genital organs lying on the ventral surface between the fourth pair of legs. The female is about 0.390 mm. long, the male 0.225 mm.

A full account of the external anatomy of the *Sarcoptes* of the horse (*S. scabiei* var. *equi*) is given by Buxton (1921a). There are grounds for thinking that the mites attacking horse and man are not to be distinguished from one another on anatomical grounds (Buxton, 1921b).

### Biology: 1. Life Cycle

The life history of *S. scabiei* is extremely difficult to follow, for the mites are very small and delicate, and much of the cycle is passed beneath the surface of the skin of the host. The best account that we have is by Munro (1919), but there are many points on which knowledge is still most imperfect. According to Munro the adult female, removed from her burrow in the skin, is capable of burying herself completely in man's skin in a very brief period: she holds to the skin by the suckers of the front legs, and elevates her body into a nearly vertical position by using the long terminal bristles of the hind legs. This is generally done on some part of the human body of which the skin is thin. Once the mite is beneath the skin it rests if the man is in a cold place, and continues to excavate its burrow only if his skin is warm, as when he is in a warm room or in bed; it is when the mite is advancing through the epidermis that the itching is felt. It is assumed that the mites feed on the liquid that is available from the epidermal cells which they crush.

A part of the life history of the itch mite may be observed by opening burrows, or by dissecting them from the underlying tissues and mounting them whole (Fig. 2). It can then be seen that the first egg is laid within twenty-four hours of the female's becoming mature. The egg may

hatch in about sixty-five hours; but the period varies (probably with the temperature of the surface of the skin), and the stage may last as long as 100 hours, perhaps even longer. The egg produces an active hexapod larva (Fig. 3), which moults into an octopod nymph: at the next moult this produces either an adult male or an immature female, which has to moult once again to produce an adult female.

The duration of the successive stages is as follows (Munro, 1919): egg,  $2\frac{1}{2}$  days or more; larva,  $1\frac{1}{2}$  to 3 days; nymph,  $1\frac{1}{2}$  to  $2\frac{1}{2}$  days; immature female, 2 to 4 days. At

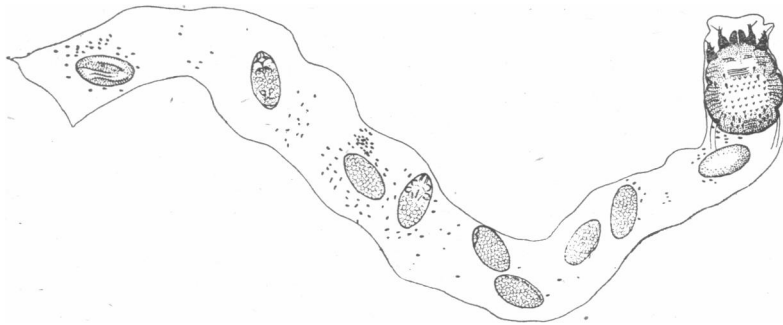


FIG. 2.—Diagram showing adult female itch mite and eggs in burrow in skin. Redrawn by H. S. Leeson, after Munro (1919).

shortest, therefore, the period from deposition of egg to emergence of adult female might be less than eight days.

The larva (Fig. 3) quits the burrow of its parent, in which it hatched from the egg, and makes its own burrow, which may be distinguished by minute vesicles beneath its floor. It seems probable that the nymph makes a separate burrow. Whether the males and immature females wander and make

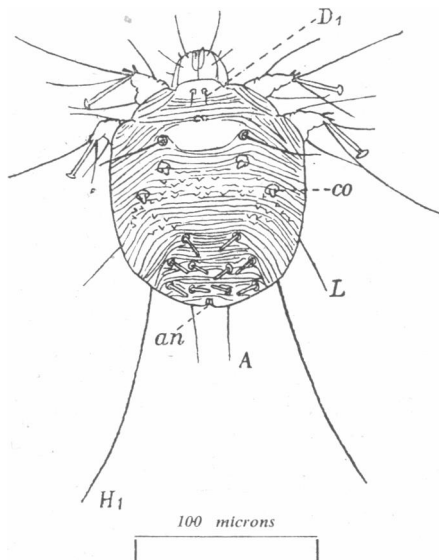


FIG. 3.—Dorsal view of larva of *S. scabiei* (Buxton, 1921a). A, anal seta; an, anus; co, cone; D<sub>1</sub>, first dorsal seta; H<sub>1</sub>, terminal seta of third leg; L, lateral seta.

their own burrows or whether they continue in that made by the nymph is not known; but it appears to be well established that the adult female does not normally move, though she can start a fresh burrow if she is forcibly removed from the skin.

The larvae, and perhaps all stages, are sensitive to dryness, and one may suppose that there is a high mortality among those which are wandering over the host's skin or clothes. Even if humidity is high, it is thought that no stage of the mite is able to survive unfed for longer than a few days, though further information would be welcome;

according to Munro (1919, p. 21) the isolated larva lives not more than thirty hours if kept moist. It is said that the infestation normally spreads to those with whom the patient sleeps, because the early stages of the mite normally wander about at night. But they are so small (the larva is only 0.15 mm. long) and inconspicuous that they have seldom been seen.

## 2. Reproduction

The pairing of *S. scabiei* has not been observed. The accepted view (Vitzthum, 1931; Warburton, 1920; and earlier authors) is that the male pairs with the immature female, and that the adult female cannot pair. But it is now thought probable that it is the adult female which pairs, and that the orifice is on a minute papilla on the dorsal surface of the abdomen, not present in the immature female. If this is so the adult female has two genital orifices, for the eggs are laid through a transverse slit, the tocostome, on the ventral side, behind the bases of the legs of the second pairs (Buxton, 1921a).

The life of an individual female has never been followed through, but it seems probable that she lays rather more than two eggs daily, to a total of about forty to fifty.

## 3. Distribution: Seasonal and Geographical

The itch mite on or in man's skin must be exposed to extremely equable conditions of climate (even more so than *Pediculus*). It is not remarkable, therefore, that it appears to be cosmopolite, and that there is little evidence of seasonal change in abundance; where seasonal changes are observed they may be due rather to the effect of climate on the human beings (who may crowd together in cold weather) than on the *Sarcoptes*. The parasite may occur in people of all ages and races.

No information exists as to the upper temperature that is fatal for various periods of exposure. Disinfestation of blankets, etc., by heat is at present based on faith alone, and probably the temperatures used are needlessly high.

## 4. Hosts

It has been known for three-quarters of a century that mites very similar to the *S. scabiei* of man occur on many sorts of mammal, causing itching and mange. These mites have been recorded from the domestic horse, dog, pig, sheep, goat, camel, llama; also from a number of wild animals, among others the wolf, polecat, fox, lion, capybara, but generally from individuals kept in captivity. The earlier authors figured and described points of difference between *Sarcoptes* from different species of mammal, and their work was summarized by Warburton (1920): it is now held that the differences recorded are due to imperfect microscopes and technique, and that the anatomical characters are variable or non-existent. Hirst (1922) states that he has examined specimens from a large number of species of mammal, domestic and wild, "without being able to find a constant morphological character by which they could be satisfactorily distinguished from one another." I myself made a full study of the external anatomy of the *Sarcoptes* of the horse, and then examined much material collected from human beings: the conclusion reached was "that the *Sarcoptes* of the horse and the common species found on man cannot invariably be separated. Certain minute differences exist in scales and spines, but they are not constant, and the measurements overlap" (Buxton, 1921b). No species of *Sarcoptes* occurs on birds.

As it seems that itch mites from man, the horse, and many other animals are not separable on anatomical points, though they differ physiologically, it is convenient to treat them all as belonging to a single species, *S. scabiei*. But as there is a high degree of specificity (see below) one would say that there are biological races associated with particular hosts. It is customary to speak of these varieties as *S. scabiei* var. *hominis* on man, var. *equi*, *canis*, *suis*, *ovis* on the horse, dog, pig, and sheep, and so on for other varieties.

### 5. Source of Human *Sarcoptes*

As we have no anatomical points by which *Sarcoptes* from different animals can be recognized one can only use the epidemiological method in studying the extent to which man may derive his infestation from other mammals. It is quite clear that one human being is normally infested from another: the itch generally spreads through a family, or a group of men living together, in the absence of infested animals. The condition is much more frequent in people who live crowded together and who have no opportunity of washing, changing clothes, etc. Moreover, experimental transmissions are on record: scabies has been transmitted to volunteers who used the underclothing or beds of infested people, or who wore gloves inside which *Sarcoptes* had been liberated (Munro, 1919; Macpherson, Horrocks, and Beveridge, 1923).

But though man generally derives his *Sarcoptes* from other human beings there are many records in which his infection was clearly traced from animals: such cases are often detected by veterinary surgeons. The disease seems to be not rare among those who keep small pet dogs, which can sleep on the bed or the lap, but it is rarer among those whose dogs are larger and less easily handled.

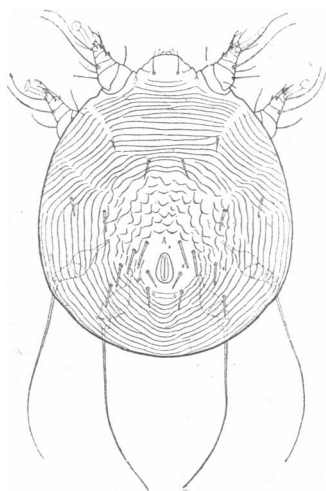


FIG. 4.—Dorsal surface of adult female of *Notoedres cati*. (From Hirst, 1922.)

It also seems probable that more human infections are derived from the horse than from other animals. The case described by Macdonald (1922) is instructive: a group of students spent periods of from two to five hours studying the dead body of an infested horse: all those who had direct contact with the horse suffered from itching and a papular eruption. In a similar way, men whose work brings them into contact with cattle or camels suffering from sarcoptic mange commonly acquire an infection; there are also records of its spreading to keepers in menageries from diseased llamas, kangaroos, chimpanzees, and other animals. The disease is therefore to some extent an occupational one among those whose pleasure or profession it is to breed dogs, nurse cats, milk cows, groom horses,

tame lions, box with kangaroos, or tend llamas. (Recent references: Sequeira, 1925; Whitfield and others, 1931. See also Warburton, 1920, for references to earlier authors.) A useful short account of the mites infesting domestic animals is given by Hirst (1922).

The mite *Notoedres (Notoedrus) cati*, parasitic on cats and rabbits (and less commonly dogs), occasionally produces infestation in cat-lovers. *Notoedres* is distinguished from *Sarcoptes* in its small size, the dorsal position of the anus, and other characters (Fig. 4).

The severity of scabies acquired by man from animals differs greatly with circumstances: in some instances the irritation is felt very soon after the mites have reached the skin—within an hour or so in some of the students described by Macdonald (1922). Mites derived from the camel appear to be particularly irritating; indeed, it is said that Roberts's famous march from Kabul to Kandahar in 1880 almost broke down owing to sarcoptic mange in the camels and in those who looked after them. It is also thought that some of the cases of crusted scabies in man may have been derived from animals (see below). It seems that the biological races of *S. scabiei* which are proper to animals are not able to establish themselves on man, and that in many cases they make no complete burrows; moreover, the original human patient is not, apparently, a source of danger to other people. This specificity of different biological races of the mite is very marked, and it has proved difficult to infect one sort of animal from another by transferring mites and crusts. To what extent human beings suffering from *S. scabiei* var. *hominis* are a source of infection to domestic animals is not known.

### Medical Importance: 1. Scabies

Scabies, or "the itch," is a specific disease caused by the presence of *S. scabiei* in man's skin. It seems that a period of eight to ten days commonly passes between the beginning of an infestation and the development of symptoms, and that period may be longer, perhaps much longer, in insensitive patients. The itching, which is the most noticeable symptom, is not caused by the presence of the mite in the skin, but by its activity in extending its burrow; it is therefore most troublesome when the patient is in bed or in a warm room.

The burrow (Fig. 2) is made in the deeper part of the horny layer of the epidermis, rarely reaching so deep as the granular layer. In sections it may be seen that the epidermis round the mouth of the burrow is oedematous. The layers of epidermis below the burrow are also frequently oedematous, with dilated lymphatics. A vesicle may be present beneath the burrow (perhaps only when the burrow is that of a larval mite—see above). In the papillary layer the blood capillaries are dilated and surrounded by inflammatory exudate. The burrow is tortuous and may reach a length of 5 to 15 mm.

Scabies is best diagnosed by finding the burrow or the mite. In a European the burrow may appear grey because its rough upper surface catches dirt and because of the faeces of the mite within it: one may make it more evident by brushing ink over the skin. It is generally agreed that the burrow is difficult to see in a brown skin. The mites will generally be found in the burrow, more rarely on the surface of the skin. Backhouse (1929), working with dark patients in Melanesia, reports finding the mite in 35% of 424 cases. It is sometimes very important to detect scabies—for instance, in order to prevent its spread through labourers in the Tropics or troops under active service conditions: failure to diagnose the condition is common. There is also a tendency in the damp Tropics to take scrapings from the skin and grow from them various fungi, which

fascinate the dermatologist and may prevent his discovering the common humdrum mite.

The infestation may be on almost any part of the body, and mites confined under watch-glasses will burrow wherever they may be. But the parts most commonly affected are those where the skin is soft or folded, as at joints.

On the clinical side one may distinguish simple scabies, in which the irritation is due to the burrows, and complicated scabies, in which the symptoms are aggravated by septic complications. Common complications are impetigo and the dermatitis which follows the unwise use of sulphur ointment. The proportion of complicated cases depends on conditions of life and the care given to diagnosis and treatment.

## 2. Crusted Scabies

Clinically this is a well-defined condition, thick crusts and callosities being found on various parts of the body, especially the limbs. The crusts, which are stratified, may project 2 to 3 mm. above the surface of the skin: large areas of skin may be involved and the finger-nails be included. Enormous numbers of *Sarcoptes* of all stages live in the crusts, but they are quite capable of burrowing in the normal way (Backhouse, 1929; and Fig. 5).



FIG. 5.—Section of skin from case of crusted scabies. Note great thickening of stratum corneum, and numerous burrows and spaces in it containing mites and eggs. Malpighian layer shows proliferation and mites lying deep in it in capsules of semi-cornified epithelium. Drawn by H. S. Leeson from a photograph by Backhouse (1929).

Generally the condition requires at least a year for its development. The accumulation of crusts, consisting of dead epithelium and dried exudate full of itch mites, renders it very much like sarcoptic mange, such as one sees in the horse. The disease is generally rare; most authors remark on the fact that the cases are isolated, one only being seen in many years.

The condition was originally described among lepers in Norway, and it is sometimes referred to as "Norwegian crusted scabies." This name is unsuitable, for the disease has been recorded from most European countries, and Turkey; also from several tropical countries, such as Brazil, French Guinea, Melanesia, and Java.

With respect to the epidemiology diverse views are held. Many authors regard the disease as normal scabies which has been neglected, perhaps because it occurs in an insensitive or very careless patient: the fact that it sometimes occurs in lepers, whose skin is so often anaesthetic, supports this view. Moreover, Beatty (1915) described a case seen in Dublin in which the infection was attributed by the

patient to his having slept a year before in the same bed as a person suffering from ordinary scabies. This view is supported by Pozzo (1920) and Mandoul (1925). The view that crusted scabies is nothing more than ordinary scabies much neglected is also held by Backhouse (1929). Some of his cases were mild and localized common itch; others were generalized; others, again, carried masses of crusted exudate full of *Sarcoptes*: the conditions graded into one another. Material collected by Beatty in Dublin has been carefully compared with a large number of mites derived from human cases of common scabies. It was found that the mites were separable only on one character—the length of the spines on the posterior part of the body; but the differences were small, and as the spines are curved they are not easy to measure (Buxton, 1921b). It would be difficult to say whether the small differences might be attributed to the conditions under which the mites live beneath the scales of crusted scabies.

The alternative view, that the mites in crusted scabies are derived from animals and are completely different from those in the ordinary disease, was held by several of the earlier authors, including Mégnin, who attributed certain cases to infection derived from wolves. More recently Brug and Haga (1930) have reported on mites derived from crusted scabies in a Chinese leper seen in Java. It is clear that their mites differed in several important characters from those which cause the ordinary disease, and it is perhaps significant that the same authors examined mites from a tame monkey, finding them identical with those from the human case of crusted scabies. In a case observed at Rio de Janeiro the mites differed from those of ordinary human scabies: it was thought that they must have been derived from an unknown domestic animal (da Costa Lima, 1927).

It seems, then, that crusted scabies may be produced in two ways. Sometimes, perhaps most often, it is ordinary itch occurring in an insensitive or neglected individual. Other cases are due to infection with *Sarcoptes* derived from animals. Both views are supported by the evidence. The third possible view, that the disease is peculiar to man but essentially different from common scabies, is not tenable because of its rarity and its tendency to appear as single cases.

Figs. 1 and 4 are reproduced from Hirst's *Mites Injurious to Domestic Animals*, by permission of the Director of the British Museum (Natural History). Figs. 2 and 5 are redrawn by my colleague Mr. H. S. Leeson from the figures of Munro (1919) and Backhouse (1929). Fig. 3 is reproduced by permission of the editor of *Parasitology* (Cambridge University Press).

## Summary

The paper deals with the external anatomy and life history of *S. scabiei* var. *hominis*, the causative organism of human scabies, and its relation to man. Destruction of the mite and treatment of the host are not discussed.

The mite is a specific parasite of man, and can live for only a short time away from him. It can go through its cycle from egg to adult in a minimum of eight days. It seems probable that two types of burrow are made—one by the larva, with a vesicle in the floor, and the other (the larger and more familiar type) by the nymphs: it is in this second type that adults, eggs, etc., are found (Fig. 2).

Normally the itch is derived from another human being. But man is occasionally infested by the *Sarcoptes* of horse, camel, etc., which appears to set up a transient form of itch.

Crusted scabies is sometimes due to prolonged neglect of ordinary scabies. There are, however, some cases which are probably due to infestation by *Sarcoptes* from some host other than man.

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## TREATMENT OF SCABIES USE OF SULPHUR LATHER TABLETS

BY

DOROTHY L. CARTER, M.B., B.S.

*Recently Assistant School Medical Officer in Middlesbrough*

The increase in the incidence of scabies, started well before the war, has now become a wartime problem. Among the school population, where information of a non-notifiable disease is easiest to find, scabies increased 90% in Heston and Isleworth, 100% in the North Riding of Yorkshire, and 50% in Coventry, in 1938. These figures are pre-war, but it is legitimate to assume that conditions which caused such an increase then will have caused a still greater increase in wartime, for the war has exaggerated many of those conditions. One of the chief reasons before the war was, as stated by Sir Frederick Menzies, the fact that "children who have been treated return to homes where other members of the family are untreated and reinfection is frequent." This fact is surely the basis for the alarming increase. Scabies is a curable disease; the remedies are varied, but the majority are effective sarcopticides. Given an isolated case of scabies few practitioners will fail to cure it in a week. The cure of the individual case is relatively easy, and yet the disease remains one of the most difficult to control, and is at present assuming the proportions of an epidemic.

Anyone dealing with scabies on a large scale will acknowledge that the more cases we cure the more we find to cure. It seems feasible, therefore, to deduce that the disease is increasing because: (1) supervision of contacts is not given the same importance as the treatment of active cases; (2) 50% of the cases never seek treatment and thus constitute a reservoir from which fresh cases are always arising. The majority of individuals in this reservoir of untreated cases are those who escape medical supervision in schools, factories, and industrial concerns—children below school age who elude the rather infrequent visits of the health visitor, mothers and female relations who do not work outside their homes, and children above school age who do not come under medical supervision at work. Medical supervision would have much reduced the incidence of the disease had it not been for these untreated cases. The importance of control of the contact is increased by the fact that the war has caused a dispersal of the family unit. A family which before the war kept its scabies more or less to its own house now carries it to the Army, the air-raid shelter, and the reception area. The soldier home on leave takes his wife's scabies back to the barracks, the school child returns to the reception area with the baby's scabies, and the "bombed-out" family crowd in with neighbours or in a communal shelter, and the

acarus, if present in clothes or bedding, spreads rapidly. Shelter life and, indeed, all conditions of overcrowding, too often associated with personal uncleanness, fewer baths, fewer washdays, all provide excellent facilities for the increased spread of scabies.

Infection is by contact. This must be close contact with an infected person's lesion or with his infested clothing, and must be long enough to allow the acarus to pass from one person to another and to establish itself by burrowing in the skin. Thus infection will result from sleeping in the same bed as an infected person, using infested blankets—for example, in the Army, the shelter, or the crowded house—or wearing an infested person's clothing; it is possible that in some cases infection passes from clothing to clothing. Infested clothing remains infective for at least eleven days (Gray, 1940).

### Importance of Effective Treatment

Scabies, which is frequently venereal (Roxburgh, 1939), is often regarded as a trivial disease; and is put with "nits" into the class of normal affections of some of the poorer people. This is unwise, for the importance of scabies lies in the fact that while it is never a life destroyer it causes much loss of sleep—an important fact nowadays. The cardinal symptom is intense irritation at night-time. The scabietic child, unless inured by months of reinfection, is pale, listless, heavy-eyed, and dull, not, of course, only because of his scabies but because of loss of sleep and his perpetually irritating skin condition. Similarly, we can ill afford to let the war worker spend his days and nights scratching, with a resultant increase in nervous tension, lack of concentration, impairment of efficiency, and eventually loss of working time.

The ideal treatment must be: (1) short and effective to reduce the period of infectivity; (2) palatable to the patient, who often has to be cajoled into continuing with it; and (3) must include all contacts and clothing. The futility of treating the school children and neglecting the contacts is expressed by Macdonald (1941): "The usual means of dealing with scabies by treating the children with clinic baths and instructing the mothers is not only inadequate but in the vast majority of cases is a futile expression of hope." On the other hand, the effectiveness of dealing with case and contacts together has been proved in Canada (Currey, 1939). On the day of diagnosis of a case of scabies the health visitor treated the case and all the contacts of school age in their own homes with benzyl benzoate lotion. All were excluded and followed up in twenty-four hours. Advice was given to the parent and lotion left for the remaining members of the family. In this way the incidence of scabies was, during the first six months of 1939, twelve families out of a school population of 5,569. This is an interesting record, for although only school-age contacts were treated, yet incidence of scabies among the schools fell to a very low figure.

### A New Method of Treatment

I have recently used a new method of treatment on children of all ages in a school treatment centre. In a small series of cases this was agreeably successful, and I think it is justifiable to add yet another to the list of sarcopticides, for this one has certain advantages over others I have used, especially in children. This treatment was first described in America (Nolan, 1937). The active principle is sulphur—the old favourite. This is incorporated in a bland soap—amount of sulphur being 18%—which is applied to the body in the form of a lather. As the lather dries a thin film of sulphur is deposited all over the body. Nolan had noted that on looking at a bubble of the lather