BRITISH MEDICAL JOURNAL

LONDON SATURDAY FEBRUARY 1 1941

ANTISEPTIC SNUFFS

BY

M. E. DELAFIELD, M.B., B.Ch.

EDITH STRAKER, M.B., B.S.

AND

W. W. C. TOPLEY, M.D., F.R.C.P., F.R.S.

Emergency Public Health Laboratory Service, London School of Hygiene and Tropical Medicine

Much time and thought have been given in recent years to studying the ways in which harmful bacteria and viruses pass from one person to another, and to devising methods by which such passage can be prevented. We have come to realize more clearly than we did the multiplicity of the avenues involved, and we have found some methods which should at least tend to decrease the traffic along them. Reference to recent papers by Andrewes (1940), van den Ende and others (1940), and Miles and others (1940) will show the magnitude of the problem and illustrate the methods by which it is being attacked. In addition to the primary essentials of good ventilation, the avoidance of overcrowding, and the adequate spacing of beds in sleeping quarters and in hospital wards, they include such measures as the use of aerosols or ultra-violet light to kill bacteria in the air, the use of spindle oil to prevent those that fall to the floor from rising again as dust, the avoidance of infected fluff from blankets, and the use of masks, worn either to protect other people from the wearer or the wearer from his environment, including other people. In attempts to prevent cross-infection among the wounded the whole range of surgical technique in the wards has been reviewed, and suggestions have been made for its improvement.

There is one conclusion to which, we think, all workers in this field will subscribe. There is no sovereign remedy. If the problem is solved it will be by strengthening all possible defences, not by developing some and neglecting others; though we may be able to allot priorities when we know more than we do now about the relative importance of the various channels of infection.

Some six months ago we started to approach one aspect of the problem from another angle. Of the many methods so far practised or advocated, most are aimed at reducing the concentration of bacteria or viruses in the air. The mask is the only measure at present in common use for preventing the passage of micro-organisms from or to the nose and mouth of its wearer. The mask will certainly be retained as an integral part of any aseptic hospital technique, and it may be possible to encourage its use as a method of personal protection in the presence of unusual risks; but for this purpose it is an inconvenient instrument, unlikely to be worn continuously or by a large proportion of all those exposed to infection or those capable of infecting others. If it were possible to replace it by some method of personal antisepsis something might be gained. It is this possibility that we have tried to explore.

If it is to be applicable on a wide scale and in a variety of circumstances any method chosen must fulfil the following conditions: (1) it must be easy to apply personally; (2) its application must not itself involve any risk of cross-infection; (3) it must maintain an adequate concentration of the antiseptic material in the right situation over prolonged periods of time; (4) it must be non-toxic, even when used continuously for weeks or months.

Among the methods that have often been advocated for personal prophylaxis is the use of antiseptic gargles. As a recent instance Young and Charteris (1940) state that they have obtained favourable results by the use twice daily of an acriflavine gargle in throat-and-nose wards.

A gargle is easy to apply personally under hospital or home conditions, and given a suitable antiseptic it is non-toxic. Unless a separate glass or vessel is supplied for each gargler, and care is taken that there is no sharing, the method is by no means free from the risk of itself providing an avenue of cross-infection. It produces its result mainly in the mouth and tonsillar region, and to a much less extent in the nasopharynx. It is doubtful whether, even in these situations, an adequate concentration of antiseptic can be maintained for very long after gargling. To maintain a bactericidal or bacteriostatic concentration throughout the twenty-four hours it might well be necessary to gargle a dozen times or more. The method will have no effect on the nose. For these reasons it did not seem to be a promising method of approach.

An antiseptic snuff seemed to offer better hopes of success. It is extremely easy to apply personally. Distributed in a separate container to each person it involves no risk of cross-infection in its application. Being in the form of a powder it adheres to the mucous membrane of the nasal cavities, and to some extent to the nasopharynx. In each person it will follow the course of the inspired air currents. There is, it may be noted, an extensive literature on the direction of these currents, which is summarized by Lucas and Douglas (1934). If the snuff is, at least in part, in the form of particles of the same order of size as a bacterium it is probable that the distribution of inspired bacteria and inspired snuff will be approximately the same. Being in the form of a powder the antiseptic will probably be dissolved slowly in the nasal mucus; and it should be possible to maintain an adequate concentration of any selected antiseptic for a period of days or weeks by relatively few daily applications. We decided, therefore, to study the effects of antiseptic snuffs.

Methods Employed

The main object that we had in view was to find some antiseptic snuff that would prevent the successful lodgment and multiplication of bacteria entering with the inspired air; but it seemed improbable that we should learn much from experiments with purposely inspired bacteria, since recognizable non-pathogens would not survive long in any case. We decided, therefore, to study the effect of our antiseptic snuffs on the existing flora of the nose and throat. It seemed probable that if these reagents proved capable of eliminating, or of greatly reducing in number, one or more of the potentially pathogenic species that are often present in the nose or throat they would suffice to hold in check fresh entrants of the same species.

Preliminary experiments with nasopharyngeal washings and with swabs taken and plated in the customary way convinced us that neither of these methods offered any hope of obtaining quantitative findings of the kind that

the fluid was drawn up in a sterile dropping pipette (50 drops to 1 c.cm.), and 30 drops were allowed to fall in the centre of a sterile 4-inch Petri dish. A sterile 7-cm. No. 1 Whatman filter paper was then lowered on to the Petri dish with sterile forceps, when, as had been found in preliminary experiments, it quickly took up the 0.6 c.cm. of fluid without leaving more than a general dampness on the bottom of the dish. The filter paper was then lowered with sterile forceps on to the surface of a blood-agar plate. As soon as contact had been made it was removed and discarded.

The plates were incubated at 37° C. for forty-eight hours and a preliminary examination made after twenty-four hours. After the full period of incubation they were placed in a blackened box, illuminated with strip lights, and photographed with a Leica camera giving a reduction of approximately 1:4.

At the twenty-four-hour and forty-eight-hour examinations of the plates the colonies were inspected, and films

FIG. 1.—Normal Subject. Left to right, blood-agar plates from right nasal cavity, left nasal cavity, nasopharynx, right tonsil, left tonsil. No treatment.

FIG. 2.—Rows 1 and 2. Subject C. Five successive blood-agar plates from right nasal cavity (Row 1) and from left nasal cavity (Row 2). No treatment.

we required. It also became clear that we should have to elaborate our method, taking separate samples from each nasal cavity, from each tonsil, and from the nasopharynx, in each subject under test. The technique finally adopted was as follows.

All subjects under test were examined three times a week on consecutive days. Using a head-mirror and a nasal speculum, separate swabs were obtained from the left and right nasal cavities, care being taken to sample the anterior end of the middle turbinate whenever possible, and the anterior portion of the middle meatus. Using a tongue depressor, three more swabs were taken, one from the left tonsil, one from the right tonsil, and one from the nasopharynx. The swabs used were as nearly as possible of the same size and were mounted on wooden handles.

As soon as it was taken each swab was emulsified in 2 c.cm. of nutrient broth contained in a 5-c.cm. screw-capped bottle. The swab was rotated twenty times and then pressed against the side of the bottle; and this procedure was repeated three times. The swabs were then discarded. After allowing any obvious particles to settle,

we made to determine the morphology of the bacteria present. In the case of staphylococci, in addition to examining for pigment formation, coagulase tests were done on colonies from many plates, but not from all. So far as other organisms were concerned no attempt was made to carry identification further than colony form and microscopical examination, except that doubtful colonies of pneumococci were tested for bile-solubility and the few haemolytic streptococci for the production of soluble haemolysin.

Although this method gave us better quantitative results than any other that we tried it will be clear that the sampling has remained inadequate, and that large variations must be expected apart from any treatment.

Fig. 1 shows the plates obtained from the right nasal cavity, nasopharynx, right tonsil, and left tonsil of a person not carrying any considerable number of bacteria in the nose. These five plates give a fair average picture of the results obtained with those persons who are not nasal carriers. The tonsils almost always give heavy growths, the nasopharynx less heavy, while the nasal cavities yield few colonies or none.

Fig. 2 shows the results of five successive nasal swabbings in a subject (C) carrying staphylococci. The plates in the first row are from the right nasal cavity, those in the second row from the left. They show the kind of variation that can be expected as the result of differences in sampling, apart from any treatment.

The Antiseptic Snuffs Tested

In preliminary experiments, and before our technique of sampling had been fully developed, we tested a variety of materials, including ordinary tobacco snuffs, and lycopodium snuffs containing sodium sulphate with or without menthol, to see whether the stimulation of the normal nasal secretion would have any bactericidal effect. The results were not promising, and by the time that we had arrived at the methods outlined above we were using snuffs containing proflavine, penicillin, or sulphathiazole, with lycopodium powder or magnesium carbonate as a base. Sulphathiazole was selected in preference to other sulphanilamide compounds because of its greater action on staphylococci. Some snuffs had menthol added, some had not. The only snuffs that need be considered further are the following.

Proflavine Snuff:

5 parts by weight proflavine
5 " " " menthol
90 " " " lycopodium

Penicillin Snuff:

1 part by weight penicillin
5 parts " " " menthol
94 " " " lycopodium

Sulphathiazole Snuffs:

10 parts by weight sulphathiazole
5 " " " " menthol
85 " " " " lycopodium

10 parts by weight sulphathiazole
1 part " " " " menthol
89 parts " " " " magnesium carbonate

10 parts by weight sulphathiazole
90 " " " " " magnesium carbonate

In the case of sulphathiazole we purposely started with minimal doses, to see whether we could obtain significant effects with amounts that would almost certainly prove non-toxic even when taken over long periods. The magnesium carbonate was substituted for the lycopodium because of the possibility that the continued inhalation of lycopodium spores might induce a hypersensitivity. For the small sample of penicillin at our disposal we are indebted to Prof. Florey. The properties of the crude substance as originally described by Fleming (1929, 1932) and by Fleming and Maclean (1930), together with the curative or protective effect of the purified product and its absence of toxicity (Chain and others, 1940), led us to hope that this might be a particularly favourable material for our purpose.

Results with Nasal Carriers of Staphylococci

In all we have examined 20 persons, the number of swabbings made from each varying between 16 and 32. None of the snuffs we have tested has had any detectable effect on the bacterial flora of the nasopharynx or tonsils. That they reach the nasopharynx can easily be demonstrated. With snuffs containing proflavine a trickle of yellow mucus can often be seen passing in a narrow stream from the posterior nares, frequently on one side only. With any lycopodium snuff the spores can easily be detected in swabs from the nasopharynx, and sometimes from the tonsillar region. It is probable, however, that the distribution is localized, and that the bactericidal substance employed reaches an effective concentration only in a few areas.

When it became clear that the only demonstrable effect of the snuffs was exerted on the nose, we examined, for nasal carriers of staphylococci, as large a number of subjects as were available. Those we discovered are included in the 20 subjects referred to above. In these carriers we swabbed the nasal cavities only, reserving complete swabbings for the six subjects who had formed our experimental material from the start of the investigation.

The results are not of a kind that can usefully be tabulated or be submitted to any statistical tests. All subjects were examined on three or more occasions before any treatment was begun. Some were given one variety of snuff only. Others who failed to respond to one snuff, or whose nasal staphylococci returned after temporarily disappearing or lessening in number, were subsequently treated with snuff of another kind. All that can usefully be done is to give some illustrative examples.

Penicillin

Four subjects in all were treated with penicillin snuff—this small number being due to the small supply of penicillin available. One subject was treated with penicillin alone. In three subjects a short treatment with penicillin was followed by further treatments with proflavine and with sulphathiazole. In all these four subjects the penicillin was effective in greatly decreasing the number of staphylococci, though one subject was carrying only small numbers before the treatment started. In the three subjects that were treated for short periods (seven to ten days) the staphylococci returned after the treatment was discontinued. Chart I shows the successive staphylo-

CHART I.—Subject B. Period of treatment with penicillin snuff. (For other details see text.)

coccal counts in the left and right nasal cavities of the subject (B) treated with penicillin snuff alone. Chart II shows the fall of the staphylococcal counts in a subject (T) treated for a short period with penicillin, and the subsequent rise a few days after the penicillin was discontinued.

In all charts the counts from the left nasal cavity are represented by a continuous line, those from the right nasal cavity by a dotted line. The figures marked along the base line represent successive swabbings, not successive days. In most subjects the routine of swabbing was uninterrupted, so that the interval between any swabbing and the third following it represents seven days.

In these and other counts the ordinates represent the number of staphylococcal colonies counted on the blood-agar plates after forty-eight hours' incubation. Counts of over 100 were recorded as >100, and are marked as 100 on the charts. Both orange and white colonies are included. The proportions of these colonies often varied widely from one swabbing to another in the same person, and coagulase tests gave positive results with many colonies that showed no trace of orange pigment. Since it was impossible to submit every colony from every plate to a coagulase test the only practicable method was to include them all. We do not think that this has involved any considerable error in the earlier parts of the records or charts. All the subjects selected for these tests were relatively heavy nasal carriers; and it seems

to be uncommon to isolate large numbers of non-pyogenic white staphylococci from the nasal cavities. It is probable that the recording of all staphylococcal colonies has tended to some under-estimation of the reduction following the use

fluctuations while taking proflavine snuff, the staphylococci were reduced to continuously low figures under the influence of sulphathiazole, the plates on many occasions being sterile. Fig. 3 shows six of the plates obtained from the right and left nasal cavities of Subject S, the first two before any treatment was given, the next two while taking proflavine, and the last two while taking sulphathiazole.

CHART II.—Subject T. P=Period of treatment with penicillin snuff. F=Period of treatment with proflavine snuff. S=Period of treatment with sulphathiazole snuff.

of the antiseptic snuffs. In most cases the small numbers of colonies isolated during the later stages of treatment have been of the white variety; but in others a few typical golden colonies have been isolated after an antiseptic snuff has been taken for several days or weeks.

Proflavine Snuff

Nine subjects were treated with proflavine snuff. All of these received other types of snuff either before or after treatment with proflavine. In almost every case there was evidence that the proflavine had an effect on the staphylococcal count, and in some instances the reduction was great; but in some subjects the count, though diminished on the average, showed wide fluctuations. In Chart II it will be noted that Subject T showed a sharp rise in both nasal cavi-

CHART III.—Subject F. F=Period of treatment with proflavine snuff. S=Period of treatment with sulphathiazole snuff.

ties soon after he began to take proflavine snuff, though previous treatment with penicillin snuff had been followed by a reduction in staphylococci almost to zero. Chart III shows the changes produced by proflavine in a heavy carrier of staphylococci (Subject S). It will be noted that, after wide

Sulphathiazole Snuff

Nineteen subjects were treated with sulphathiazole snuff. Ten of these were treated with sulphathiazole alone. The other nine had previously been treated with proflavine or with proflavine and penicillin. The results in general were very promising. Several subjects showed a great reduction in staphylococci; in some these almost disappeared. Two cases have so far proved relatively resistant, though in one of these there was a reduction in one nasal cavity after three days on sulphathiazole and in the other after seventeen days. Chart IV shows the reduction in staphylococci in Subject W under treatment with sulphathiazole, and Chart III shows, in Subject S, the effect of sulphathiazole following proflavine. Fig. 4 shows six of the plates obtained from Subject W, the first three before taking sulphathiazole, the second three afterwards. The plates in the first row were obtained from the right nasal cavity, those in the second row from the left.

CHART IV.—Subject W. S=Period of treatment with sulphathiazole snuff.

Control Snuff

During an early stage of the investigation three subjects were treated with a control snuff containing only menthol (5%) and lycopodium. None showed any significant change in the nasal flora.

Results with Other Organisms

Staphylococci were not, of course, the only organisms cultivated from the nasal cavities of these 20 persons. In regard to other bacteria a few points are worth noting. Several subjects carried a diphtheroid bacillus which had the morphological appearance of Hoffmann's bacillus but was not further identified. The action of sulphathiazole snuff on this was dramatic. The organism in most cases entirely disappeared shortly after treatment was started. It is quite possible that both penicillin and proflavine would have produced a similar result had similar cases been treated with these snuffs.

A Gram-negative coccus of the *N. pharyngis* type was present in a few subjects. This proved much more resistant than staphylococci both to penicillin and to sulphathiazole. We had no opportunity of testing its resistance to proflavine.

The findings in regard to pneumococci were curious. Not many subjects were nasal carriers of this organism, but in a few cases it appeared while a subject was taking

sulphathiazole snuff, and in some others this snuff failed to rid the nasal cavities of pneumococci that were already present. We have had no opportunity of estimating the effect of penicillin or proflavine on nasal carriers of this organism.

Antiseptic Snuffs in Relation to Colds

There is no evidence that any one of the three antibacterial substances tested has any action on filterable viruses. They would not therefore be expected to have any effect in preventing the acute infectious cold, and no such effect was in evidence. Several subjects developed colds, in most cases very mild, while taking one or other of the snuffs. There was, however, a suggestion that the sulphathiazole, and perhaps the proflavine, had an effect in modifying the course of a cold. One subject with a long

Discussion

The cases examined in this investigation are far too few to justify any definite conclusion. In normal times we should have hoped to study many more cases before publishing our findings. But the times are not normal, and we are therefore putting these findings on record in the hope that others may be able to test the significance of the results we have obtained, which at the moment are clearly no more than suggestive.

Of the three snuffs we have tried we should not ourselves regard it as worth while to proceed further with proflavine. It has proved less effective than either penicillin or sulphathiazole, and its bright yellow colour is singularly unattractive on the nostrils, the upper lip, or the handkerchief. It seems quite probable that penicillin

FIG. 3.—Rows 1 and 2. Subject S. Six blood-agar plates from right nasal cavity (Row 1) and from left nasal cavity (Row 2): 1 and 2 before taking snuff, 3 and 4 while taking proflavine snuff, 5 and 6 while taking sulphathiazole snuff.

FIG. 4.—Rows 1 and 2. Subject W. Six blood-agar plates from right nasal cavity (Row 1) and from left nasal cavity (Row 2): 1 to 3 before taking snuff, 4 to 6 while taking sulphathiazole snuff.

history of characteristic colds in previous winters developed a cold that lasted for several weeks, with a relatively copious mucous discharge. Contrary to the experience of earlier years the mucous discharge remained clear throughout, plates from the nasal cavities remained almost sterile, and there were none of the symptoms usually associated with the later stages of a cold when the discharge has become purulent. Another subject, whose nasal cavities were not being swabbed, had a similar experience. A third person, also not included in the bacteriological survey, started to take sulphathiazole snuff on the second day of an acute cold. This cold cleared rapidly, and without the muco-purulent discharge to which the person in question was accustomed. We have had no opportunity of studying the effect of penicillin snuff in similar circumstances.

will prove particularly effective as an antiseptic snuff. We hope later to have an opportunity of putting it to a more adequate test, alone or in combination with sulphathiazole. At the moment we think that the snuff most worth testing is the simple mixture of sulphathiazole and magnesium carbonate, though we suspect that the percentage of sulphathiazole might be increased with advantage. As regards administration, it seems better to avoid using the fingers and so possibly contaminating the snuff in a box. We have dispensed the snuff in small cardboard pill-boxes holding about 1 gramme. An easy method of taking the snuff is to cut or tear a small triangle of paper, and to load one corner with a large pinch of snuff for each nostril. In recent trials we have, quite arbitrarily, instructed the subjects under test to take the snuff six times a day. Used at this rate 1 gramme lasts for three to four

days. This involves the taking of approximately 0.03 gramme of sulphathiazole a day. It is very doubtful whether even this small amount is absorbed. Certainly much of the snuff remains in the nasal mucus, and thence escapes on to the handkerchief. It seems very unlikely that any toxic symptoms would develop from doses of this order, however long they were continued. In view of the apparent failure of sulphathiazole, in the doses employed, to act effectively on pneumococci, against which the drug is known to be active, we think that larger or more frequent doses of snuff, or a higher concentration of the drug, might well be used in future tests.

How far the snuff will be useful as a prophylactic it is impossible to say. It seems reasonable to suppose that, in so far as it can diminish the number of existing pathogens in the nasal cavities, it should help to prevent the multiplication of fresh entrants of the same species in the same situations. As has been noted, an antiseptic snuff has no demonstrable effect on the pre-existing flora of the nasopharynx. It does not follow that it will not reduce the frequency of successful colonization by new entrants through the nasal passages. Some of them may be caught and destroyed on their way through the nose. Moreover, as has been noted above, the snuff certainly gains access to the nasopharynx, and some of it adheres to the mucosa and must therefore lead to a local concentration of the antiseptic. Since inspired bacteria will probably lodge in the same situations, the snuff may be more effective in dealing with these than with the more widely dispersed normal flora. On bacteria breathed in through the mouth it will presumably have little if any effect.

So far as the cure of nasal carriers is concerned, it will be noted that we have not yet succeeded in freeing the nose completely from staphylococci, and have no data as to what happens after the taking of sulphathiazole snuff is stopped. It seems very probable that treatment would have to be continued for a long time to effect any permanent cure, and that, in cases in which organisms are vegetating in deep crypts or in any of the nasal sinuses, an antiseptic snuff would do no more than hold in check the surface colonization.

There is one general criticism that might be made of all our findings with proflavine and penicillin snuffs. It might be argued that the low counts obtained during the period of treatment were due not to any diminution of staphylococci in the nasal cavities but to a reduced growth on our plates resulting from the carrying over of sufficient proflavine or penicillin to produce an inhibitory effect. We do not think that this possibility can be ignored. Swabs were never taken less than two hours after the last administration of snuff, but the active substance may dissolve and diffuse slowly in the nasal mucus. The concentration of the antiseptic in the broth suspension probably varied widely as the result of sampling differences, and may sometimes have been sufficient to inhibit growth. We have no records of swabbings taken several days after proflavine snuff had been discontinued and no other snuff substituted; but Subject T remained almost free from staphylococci for eight days after a short course of penicillin snuff, and it seems very unlikely that an inhibitory concentration could have been present at this period.

The same criticism does not apply to the results obtained with sulphathiazole, since this substance has no inhibitory effect on the growth of staphylococci on plate cultures.

With these reservations we think that the following suggestions are in conformity with the very scanty evidence.

1. An antiseptic snuff containing sulphathiazole or penicillin may lessen the frequency of effective invasion of the nose by bacteria or the invasion of the nasopharynx through the

nose. It may therefore prove of use as a prophylactic against bacterial infections of the upper respiratory tract and perhaps against cerebrospinal meningitis, though on the latter point we have no direct evidence apart from the known activity of the sulphanilamide compounds against the meningococcus. The most that can be said at the moment is that the method seems worthy of trial.

2. There is no evidence that it will prevent or cure the common infectious cold. It may favourably affect the course of a cold by preventing secondary bacterial infection.

3. It may perhaps prove effective in curing nasal carriers of staphylococci or in reducing the number of vegetative organisms, so that the carrier becomes less dangerous as a source of infection to others.

4. In view of its action on diphtheroids it seems desirable to test its possible usefulness in the treatment of nasal carriers of diphtheria bacilli.

5. How far it will affect other pathogenic organisms in the nose there is as yet no evidence.

Since none of the antiseptic snuffs we have tested has had any effect on the nasopharyngeal or tonsillar flora we have attempted to influence these flora by the use of tablets containing proflavine or sulphathiazole. These tablets have been gently sucked in the hope of inducing an effective concentration in the throat. Neither has given any demonstrable results, and the aesthetic effects of proflavine tablets have been even less attractive than those of proflavine snuff. We are now investigating the possibility of influencing the nasopharyngeal and tonsillar bacterial flora by the oral insufflation of antiseptic powders; but these trials are as yet in their earliest stages.

Finally we wish to express our thanks to all those who have co-operated with us by taking our snuffs and by submitting to repeated swabbings over many weeks or months.

REFERENCES

- Andrewes, C. H. (1940). *Lancet*, 2, 770.
Chain, E., Florey, H. W., Gardner, A. D., Heatley, N. G., Jennings, M. A., Orr-Ewing, J., and Sanders, A. G. (1940). *Ibid.*, 2, 226.
Fleming, A. (1929). *Brit. J. exp. Path.*, 10, 226.
— (1932). *J. Path. Bact.*, 35, 831.
— and Maclean, I. H. (1930). *Brit. J. exp. Path.*, 11, 127.
Lucas, A. M., and Douglas, L. C. (1934). *Arch. Otolaryngol.*, Chicago, 20, 518.
Miles, A. M., Schwabacher, Herta, Cunliffe, A. C., Ross, J., Paterson, Spooner, E. T. C., Pilcher, R. S., and Wright, Joyce (1940). *British Medical Journal*, 2, 855, 895.
van den Ende, M., Lush, D., and Edwards, D. G. ff. (1940). *Lancet*, 2, 133.
Young, G., and Charteris, A. A. (1940). *British Medical Journal*, 2, 489.

Malaria in Bengal.—In his report for 1938 Lieut.-Colonel A. C. Chatterji, Director of Public Health, Bengal, states that malaria took away 416,521 lives with a death rate of 8.3 per mille in the year under review, against 372,992 with a death rate of 7.5 per mille in 1937—an increase of 10.6% in the death rate. Malaria accounted for 50.8% of the total fever mortality and for 31.0% of the total provincial mortality. The statistics provide clear and telling evidence of what the future of Bengal villages will be unless adequate measures are devised without loss of time. Malaria is the most important and direct cause of physical unfitness and extensive economic ravages of the population. In Bengal 93% of the people live in villages, but the proportion of malaria between the rural and the urban areas is 99.3 and 0.7 respectively. Altogether 4,273,307 cases of malaria were treated in 1938 in the various hospitals and dispensaries in Bengal, but this number is only a small fraction of the annual malaria incidence in rural and urban areas. It has been estimated that the total incidence is somewhere between 30 and 40 million cases out of a population of 51 millions in this Province of India. Bengal could easily consume 350,000 lb. of quinine every year in the treatment of malaria, but during 1937–8 the amount used was only 112,353 lb. The comprehensive malaria survey of representative areas in different parts of the Province was continued uninterruptedly during the year. The mosquitos collected from the villages surveyed were identified locally by trained assistant epidemiologists in charge of survey parties, and were also sent to the Bengal Malaria Research Laboratory, Calcutta, for checking and confirmation.