INCINERATION IN INDIA.

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Of the many problems of Indian sanitation there can be few which are receiving more attention at present than incineration. Although the matter might better be left to abler advocacy, I am complying with a request to embody the results of some years of practical experimentation in an article which will place these results at the disposal of those of my brother officers who, from choice or necessity, are interested in the work which is being done in India with a view to rendering this method of conservancy a practical success.

The consideration of this problem naturally embraces the following headings:—

(1) Its evolution.
(2) Its present position.
(3) Its progress towards solution.

(1) Evolution of the Problem.

The statement that the backwardness of Indian as compared with European sanitation is due to lack of funds is often made with reference solely to the executive aspects and takes no cognisance of the fact that the slow evolution of sound methods is, in no less degree, the product of economic influences. Economic rather than humanitarian considerations must govern the extent of legitimate expenditure on purely sanitary measures, and the sanitarian must recognise that his proposals must be submitted to the cold logic of the statistician and the economist.

Every day's sickness of the British worker involves immediate loss to the State—hence it has proved to the interests of the State to retain the services of a few whose life-work has been devoted to a study of means to combat conditions iminical to the health of the many. The accumulated experience of years of this highly specialized work has produced the advanced state of British sanitation.

On the other hand, the soldier in India lives only to fight; loss to the State from his sickness during peace would only result if he were incapacitated when wanted to go on service. Hence the economy of providing specialists and funds for studying the causes of his sickness has not been so obvious from the military as from
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the civil standpoint. As the problem has presented itself, it has been safer to add to the peace strength a proportion allowing for sickness than to incur expenditure in the hope that reduction of sickness would enable a smaller peace strength to place the same fighting force in the field. It was undoubtedly a wise conservatism to await presumptive evidence that sickness would be reduced by that expenditure; but the lack of special workers and funds delayed that demonstration for many invaluable years. It would probably have been delayed far longer but for the realisation of the fact that sickness is a more powerful factor than the enemy in determining whether the fighting force placed in the field can be effectively maintained there. The era of the special worker has dawned, and it is to be hoped that, in the interests of the Service, experimental funds will be placed at his command.

Other influences than that of lack of funds have borne a large part in delaying the experimental work needed. Formerly devastating epidemics dwarfed the results of sanitary improvements and focussed attention upon the water-borne theory of specific intestinal disease. The death-rate from cholera in 1896 amounted to over three times the death-rate from all causes in the last available return. Attention to the water supplies reduced the incidence of cholera by over 90 per cent. in twenty years, and so great a success led to persistence in attempts to perfect that one means of protection at the expense of all others. It was only the increase of enteric to 200 per cent. in the same period that made it generally recognised that other, and possibly determining, causes had to be sought than those dealt with by the water-borne theory. The army in India is deeply indebted to those pioneers of recent progress who, long since, drew attention to the dangers inherent in Indian conservancy methods of dealing with specifically infected human dejecta.

The trenching system, if effectively carried out, was well adapted for protection of water supplies from specific contamination; it, however, afforded serious scope for the spread of infection by other agencies—notably by diptera—before, and often after, disposal of the materies morbi under ground. The importance of this aspect of the question was only just being generally realised when it was unfortunately obscured by the discovery of the "enteric carrier"—the word "unfortunately" being used advisedly with due regard for the probable relative frequency of carrier-borne and fly-borne infections in cases of specific intestinal disease. The obvious importance of discovering the carrier, when existent, is by no means minimised
by an appreciation of the comparative rarity of carriers, and hence of carrier-borne infections; the fly, on the other hand, is ubiquitous and its means of access to possibly infective human dejecta were little interfered with until comparatively recently. If extended observations made elsewhere be applicable to Indian conditions, it would appear that if all soldier post-enterics had been employed as cooks for five years after convalescence, the average of the past ten years would have given a carrier proportion among all cooks employed of only 3 per cent. at any given time. The normal proportion of carriers among cooks in the absence of all attempts to exclude post-enterics would, on the average of the last ten years, amount to about 1 per cent.

It is satisfactory to note, therefore, that the tendency to regard, formerly, infection of water-supplies and, latterly, the enteric carrier as the sole or dominant factor in the conveyance of specific intestinal infections has given place to a broader view, and there has thus again come to the fore the necessity of evolving some method of disposal of human excreta which does not involve that exposure which is so dangerous a feature of the trenching system.

The accumulated experience of European sanitation being inapplicable to Indian conditions, the army sanitarian has had to commence this study almost de novo. Methods of biological treatment were tried, under Lieutenant-Colonel Aldridge's direction, and proved to be not only practicable, but to present economic advantages over that of trenching. They were, however, hampered by lack of water; by lack of sufficient drainage gradient in most stations in the plains; and by the disproportionately large ground area covered per unit of population. The need for highly specialized supervision has also militated strongly against general adoption of this valuable method.

The intermittent attention which has been paid to the only other alternative—incineration—has consequently been concentrated. Before the many details regarding its general applicability to Indian conservancy requirements can be finally solved, there is a vast amount of careful observation to be made, and the last word will not be spoken probably for many years to come. Meanwhile funds are urgently needed for that experimental work, by which alone can be obtained those precise data which will enable an accurate estimate to be made of the adaptability and advantages of this method, both in times of peace and war. Considerable advances have been made already, and it is clearly indicated that those who have had the opportunity for systematic trials should
place their results on record, where they will serve for the guidance of subsequent workers, who will thus be spared much vain repetition of pioneer work already done.

**THE PROBLEM IN ITS PRESENT STAGE.**

The questions which the Combatant Authority refers to the Sanitarian are these:

1. Will adoption of incineration increase the fighting strength which can be placed and kept in the field?
2. Will this method increase the cost of conservancy, and, if so, to an extent disproportionate to any advantages it may possess?
3. Is adoption of this method practicable under present conditions?

It is evident that the order of relative military importance, in which these questions have been arranged, must be reversed in the attempt to provide the solutions. An attempt to deal with this important matter in a business-like manner must first demonstrate its practicability; then trials must be secured on a small scale which will afford data for estimating its cost as compared with existing conservancy methods; and, finally, such extended trials must be carried out as will enable reliable information to be compiled, showing its influence upon the sick rate.

**Practicability.**—This obviously needs no demonstration in the abstract; what we have to consider is, whether we can incinerate with the fuel available, and without causing an amount of offence which will materially interfere with the comfort of those incinerated for.

Can the types already evolved incinerate with the fuel available? Certainly, as regards quality, probably as regards quantity? It is not suggested that they are other than illustrations of stages on the way to perfection, but if moderate funds were placed at the disposal of any one of the recognised experts, that practical perfection would be well in sight in the course of a few months.

Respecting offence, I need only quote the experience of my own headquarter station, in which incinerators have increased year by year since 1908, thus—one, seventeen, forty-eight, sixty. Justifiable complaints were made at first, but they died away as crude open patterns were replaced by closed types; and, as far as I know, the opposition is now confined to one hyper-aesthetic officer, near whose house an incinerator was at work for six weeks before he accidentally discovered it, and, simultaneously, that he could no longer dine in his house unless the incinerator were abolished. As I write,
there are two "Sialkote" type destructors in full blast near my bungalow—one within 40 yards—but none, save the most fastidious, could take legitimate exception to the occasional smell of burning organic matter which results.

The difficulties to be faced in dealing with field service conditions are greater, and especially so with regard to incineration for a force in war time. Not only must portable types be used, and under unfavourable circumstances, but it must be recognized that on active service transport and fuel may be limited, uncertain, or unprocurable. This aspect of the problem has been approached with a full recognition of these difficulties, and the details to be given later will show that there is good reason to believe that they, too, are well on the way to solution.

Comparative Cost.—Extensive trials are now being carried out in many Indian stations which, if organised, would soon provide the necessary data for a sound comparison of the relative cost of this and other methods of conservancy. At present, the reported results form an undigested chaotic mass of non-comparable data defying all attempts at standardisation. Capacity is expressed in terms of persons, lines, gallons, baltis, buckets, or latrines; fuel expended is measured by cart-loads, pounds, cubic feet, stables or, more often, not measured at all; while in very few instances can reliable figures be obtained as to what is perhaps the most important point of all—the amount of fluid which can be disposed of. Control of this experimental work by central co-ordination would ensure that trials were carried out under parallel conditions; that various special points were distributed so that each received its due meed of attention; and would lay down a form of report which would make all results obtained strictly comparable for general reference. The form of report now suggested would give the information required for each incinerator, in terms in which results might advantageously be expressed, thus:

<table>
<thead>
<tr>
<th>Station</th>
<th>Season</th>
<th>Type of incinerator</th>
<th>Cubic capacity of combustion chamber</th>
<th>Average consumption in twenty-four hours of:</th>
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<td></td>
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<td>(a) Solid excreta of number of persons*</td>
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<td></td>
<td>Europeans</td>
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<td></td>
<td>Natives</td>
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<td></td>
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<td></td>
<td>(b) Gallons of fluid (allowing 5 ounces per head for urine passed when defaecating)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(c) Fuel—variety</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Founds</td>
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* The solid excreta of natives averages 180 per cent. that of Europeans.
These data are necessary for the determination not only of the value of incineration, but also of the comparative values of various patterns of incinerator. Adoption of this, or a similar form of report would furnish this information in as many months as it will take years to collect it under present conditions.

Results would be rendered still easier of comparison if there were appended to the above form the ratio between a unit of fuel burnt—100 lb. being suggested as a convenient unit—and the number of persons whose faces are consumed and the gallons of fluid disposed of, thus: Per unit of fuel; persons 64; gallons 10.

When the data thus made available come to be considered, the economic aspects of the question whether this method should be adopted will fall naturally under two distinct headings:

(a) Conditions in which excreta and refuse possess definite manurial values, which must be sacrificed, i.e., in cantonment.

(b) Conditions in which the manurial value of neither need be considered and both may be advantageously disposed of by the utilisation of refuse for the destruction of excreta, i.e., on field service.

Regarding the latter, the financial equation is simply this: “Is it cheaper to burn or to bury?” If the factors of flies and sickness be included in that equation, the answer will undoubtedly be, “to incinerate.”

The Service must leave to ethical experts the decision as to how far it is justifiable to dispose of waste products in the easiest way possible, irrespective of the continuous and unbalanced drain of nitrogen from the soil; we cannot, however, ignore the manurial values of the excreta and litter which it is proposed to dissipate in smoke, and the consideration of those two waste products must be undertaken separately.

It is estimated in England that the value per head per annum of human dejecta is 7s. 4d., of which urine and faces represent 6s. 8d. and 8d. respectively. The British cultivator has long since realised the trifling value of night soil, which has ceased to have any market value whatever. In India a slower appreciation of the same fact is embarrassing cantonment authorities by depreciating the rentals of trenched lands until, in some instances, all that can be obtained is permission to trench gratis in cultivated areas within cantonment limits. This fact must be faced in conjunction with that of an analysis of the statistics for a quinquennium from all Indian stations with a strength of 500 and over, which showed that in those stations in which no night-soil was trenched within...
cantonment limits the enteric rate was only 32 per cent. of that which obtained in stations in which that insanitary procedure was still carried out. These two facts make it obvious that, if only in the interests of economy, some other method than trenching must be sought for the disposal of human excreta, and the alternative lies between biological methods and incineration.

The difficulties which militate against the adoption of biological methods in India have already been briefly enumerated and are frankly admitted. None the less, after an essentially practical experience of those methods, sewage farms, incineration and trenching in India, I have no hesitation in advancing the opinion that the disposal of the effluent from a biological installation on a sewage farm affords a possibility of effective conservancy in the plains without facing a perpetually recurring loss. It would be impolitic at this juncture to discuss the causes responsible for the non-adoption of this method, and the failure even to thoroughly investigate its possibilities—such causes are only too familiar to the Indian sanitarian—but it is permissible to point out that one powerful deterrent is the initial cost of providing the necessary water-latrines, of which the pattern devised by Colonel T. P. Woodhouse is so excellent an example. As biological methods are not the subject of this paper, they may be dismissed without further comment than that it is only the value of irrigation in Indian cultivation which enables sewage farming to present so great a probability of securing a lucrative return on the capital outlay required.

Similarly, it is only the failure of trenching together with the reluctance to embark on heavy initial expense for biological installations which gives incineration any claim to consideration. Slender as that claim is, it depends for its mere existence upon a demonstration of our ability to thus dispose of urine as well as feces: a dual system of destructors for solids and trenching for urine must clearly involve a heavy, if not a prohibitive, loss. Therein lies the utmost importance of utilizing every thermic unit evolved in oxidation and therein too is involved the condemnation of all forms of “open” incinerator—apart from the valid objection to the foul smells produced by incomplete combustion.

Having got thus far, we are confronted with the consideration whether it be possible to dispose of the urine by evaporation, and thus preserve its valuable solids. It is evident that such a procedure could never pay as a commercial undertaking for this sole purpose, but if an amount of refuse providing the necessary caloric energy must be burnt in any case, it becomes an immediately
practical question whether we cannot devise some means whereby
the wasted heat may be utilised to advantage in securing a valuable
by-product. If we can succeed in recovering an appreciable part
of the alleged value of such urinary solids, we might thus place
incineration methods upon a sound financial basis. The purely
commercial side of this matter must, of course, be referred to the
manufacturing chemist or the scientific agricultural expert. The
practicability of this suggestion has meanwhile been worked out
and demonstrated by means of an urine-evaporating tray forming a
false roof to the combustion chamber, the details of which will be
discussed with those of the newest types of incinerator.

The disposal of litter lacks the urgency attaching to that of
disposal of human excreta in that, presumably, infective organisms
are absent from the former. In so far, however, as stable litter
provides muscidae with their most favourable breeding-ground,
whence swarms of young flies emerge to feed impartially on human
excreta and human food, it is essential that the opportunities for the
deposition of ova should be reduced to a minimum. As wholesale
incineration is impossible without the fuel value of litter, we must
obtain an estimate of the loss to Government grass farms if no
litter were available as manure. The estimates submitted by the
government farm authorities cannot but be regarded as inflated in the
light of the success which attends manuring of grass lands at home.
Allowance for the fullest possible influence of Indian climatic con­
ditions still leaves some estimates unacceptable. It is not enough
to state that abandonment of shallow refuse trenching would in­
volve a specified heavy loss, diminishing annually for a period of
twelve years; what is required to enable an accurate estimate to be
made is a careful calculation of how much of the increased yield
which follows turning of the soil plus digging in of litter is due
severally to each of those factors in the one process. Such a
differential estimate has not been forthcoming so far, and the
total loss has been attributed solely to the absence of litter.

The practical importance of this point lies in the fact that
the essential is a cheap matrix for absorption and distribution of
the semi-liquid material to be incinerated. It is thus evident that
wood need not be considered, while it is probable that sawdust,
which would serve admirably, would prove too expensive—although
it would be advisable to obtain quotations in view of the needs of
some hill stations, in which fuel is as unobtainable locally as trench­
ing sites. The present position, therefore, is that grass or litter
must be used, and the question thus resolves itself—Is the value of
the increased yield of grass consequent on surface trenching of litter, after deducting (a) cost of cartage and labour, (b) yield resulting from turning of the soil only—less or more than the cost of purchase and delivery at the incinerator of the equivalent combustion value of grass fuel? The lines upon which such an experimental determination could be carried out are obvious, and reliable data could be made available in a single season.

Without the introduction of details, which have been purposely excluded from these initial considerations of the general aspects of this complex problem, it is noted that an index of the matrix and fuel value of litter is afforded by the fact that the newest type of incinerator has disposed of 1.3 lb. of liquid for every 1 lb. of dry litter burnt. This result was actually obtained for the months of July and September—i.e., under monsoon conditions—and expresses the average for those months. Evidence is thus afforded not only of the importance of obtaining litter fuel but also of the extent to which an ample supply of that fuel would render it possible to dispose of urine with safety and, at the same time, obviate the expense of maintaining a dual system of conservancy.

Influence of Adoption of Incineration upon the Sick-rate.—This, the question of first importance from the purely combatant standpoint, is necessarily the last in chronological order of solution. It calls for the briefest consideration at this stage, in that its final solution will only be possible in the light of information secured by extended trials. Failing such demonstration, it is only necessary to consider what reasons the medical authorities can advance for presupposing the success of those trials. Without digression into irrelevant considerations the skeleton facts of our arguments, from the scientific standpoint, would appear to be based on our knowledge of infective intestinal disease—of which enteric stands as the type, because of its relative prevalence and, as a corollary, our more definite information of the factors in its causation. The ascertained facts are:

(1) Enteric infection is derived solely from a previous case of the disease, discovery of the "carrier" having disposed of many, or all, of the difficulties in the way of accepting this belief.

(2) Infection, in so far as it concerns conservancy, occurs by conveyance of the infective organism from the dejecta of a previous case to the alimentary tract of non-immune persons. Infectivity of dejecta has been shown, in the case of the "carrier" and, still more recently, in the enteric case at the very earliest stages of disease, to be far more common than was formerly supposed.
(3) That the conveyance of infection may be effected by flies and, probably, by aerial diffusion of dust.

If these facts be accepted, it follows that the essentials for a conservancy method are that it should ensure the speediest possible destruction of infective dejecta; afford no access of flies to dejecta; and, as an additional protection, reduce the number of flies to the minimum. In proportion as incineration effects these desiderata better than trenching, to that extent, ipso facto, is it the better conservancy method.

There are in addition certain statistical data which contra-indicate trenching, but such evidence must necessarily be, and admittedly is, slender, nor can reliable statistical data be obtained, save by extended trials under parallel conditions as advocated.

Having reviewed the evolution of this problem; having studied the form in which it is presented to us for solution by the combatant authorities; and having discussed its general bearings, the way is now clear for a detailed consideration of some of the types of incinerator which have been evolved, and some of the facts which have emerged from their practical trials.

(To be continued.)