BULLETINS
FROM
THE INSTITUTE FOR MEDICAL RESEARCH
FEDERATION OF MALAYA
No. 3 of 1949

AN EPIDEMIC OF TYPHOID FEVER
DUE TO ICE-CREAM

BY
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KUALA LUMPUR:
PRINTED AT THE GOVERNMENT PRESS.
1950.
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BY

R. GREEN AND D. S. MANKIKAR.

Typhoid fever invaded a town with a population of about 5,000. One per cent. of its school children became infected, and more than 100 persons in the town and outlying districts eventually contracted the disease.

The infection first showed itself in epidemic form mainly among school children, initially Chinese and then Malay. Later, transmission to adults, seemingly mostly from the children, became fairly common in families. Eventually the disease was brought to an abrupt termination in the town by removal of the cause, but it tended to linger on by familial transmission in outlying “kampongs” among Malays.

For many months prior to the outbreak, exceptional efforts had been made by the Health authorities to have all food hawkers in the whole of the State thoroughly examined to see if they were typhoid carriers. The towns of this State were relatively small and the numbers of hawkers in each not unwieldy as in some towns of larger States. These efforts met with unusual success; and among 300 hawkers examined, two were found to be constant excretors of typhoid bacilli, and were prevented from infecting the general public. Eight others had “suspicious” Widal reactions, possibly residual from old or unnoticed systemic infections, but were found, after frequent and prolonged examination, not to be typhoid carriers.*

Despite this constant vigilance, however, one man, by a series of unfortunate coincidences, defeated the preventive activities which had been so widespread, so carefully applied and hitherto so successful. He escaped detection as a typhoid carrier by a very narrow margin.

He was an ice-cream maker whose products had been condemned in a small town of another State, because of his unsatisfactory methods of preparation (confirmed by his ice-cream there showing a bacterial content of more than one million organisms per c.cm.). All ice-cream making in this town had then been taken from him also other small manufacturers and given solely to one large firm which had a modern plant capable of turning out a cleaner and better ice-cream. As a result this man, an enterprising Chinese, migrated to another State to ply his trade and he chose, for various reasons, the small remote town which was later to suffer from his presence.

There, profiting by his recent experience, he managed to set up a bigger and better plant than his rivals, partly with a view, in turn, to ousting them. This he finally did by satisfying the Health authorities (with whom he was now familiar) that his equipment was far in advance of the others. A single factory for the whole town and district also facilitated sanitary control.

First of all, however, prior to acquiring his manufacturing plant, he presented himself for examination as a possible typhoid carrier in accordance with the local sanitary procedure. His Widal reaction was found “suspicious” [T(o) 4 units; T(H) 1/192] and three bacteriological examinations of faeces and urine were advised after purgation with magnesium sulphate. The first specimens were found negative for B. typhosum, but the second and third series were, by some oversight, not sent.

* A positive or suspicious Widal reaction does not, by any means, denote the typhoid carrier state, either among cases, convalescents or healthy contacts. See I.M.R. Ann. Rep., 1937, p. 10.
He was a healthy-looking individual, had had no fever; and was granted his licence to manufacture. As mentioned, he then settled down to acquire the expensive plant necessary and, cuckoo-like, displaced all the smaller manufacturers. These, his former rivals, he magnanimously employed and they distributed his product far and wide. To increase "sales-appeal" his ice-cream was designated as coming from the "Antarctic Ocean and Company" (Nam Ping Yeong Kung Sz.).

Then cases of typhoid fever occurred in schools, but the attention of the authorities was unfortunately, but quite reasonably, diverted to two hawkers (one of whom was selling ice-cream at the schools) who were found to have "suspicious" Widal reactions but who eventually, after very thorough examination, proved completely innocent as typhoid carriers. These two hawkers had early been removed on suspicion, and it was at first assumed that they might be the cause, but cases continued to occur. None of the ice-cream manufacturer’s other distributors* proved to be typhoid carriers and none had suspicious Widal reactions.

It was then requested that this Institute undertake an investigation of the epidemic.

Re-analysis of the distribution of the cases by age, chronological order, and locality re-focussed suspicion on some common food product. So, among others, the ice-cream manufacturer himself was re-examined and his Widal reaction [Vi 1/25, T(o) 7 units, T(H) 1/250] was found somewhat higher than eight months previously [T(o) 4 units, T(H) 1/192] when he was negotiating to set up his factory. His feces yielded, on five examinations out of seven, a profuse growth of *B. typhosum* but of a most unusual type; for it was particularly slow in growing on all culture media, formed tiny dew-drop colonies only after 48 hours incubation and, normally, would have been overlooked in most bacteriological laboratories, because culture tubes and plates would probably have been then discarded and because of the late growth and unusual appearance of the typhoid colonies.

Although this manufacturer was a fairly constant excretor of virulent typhoid bacilli, he gave no history of even a mild illness for many years previously and was a particularly healthy-looking and active individual. His methods of ice-cream manufacture were, in common with his fellows, such that excretal contamination of the product was daily almost inevitable for two main reasons:

(i) He gave "body" and richness to his ice-cream by adding coconut "milk"† (made by squeezing repeatedly the grated flesh of the coconut by hand in a bucket containing tap water).

* An ice-cream hawker "typhoid carrier" who merely distributes ice-cream made by someone else, may contaminate his semi-solid ice-cold wares (usually on the outside) but the typhoid bacilli have, as a rule, no opportunity of multiplying unless the ice-cream melts, reaches "room temperature", and is then re-frozen for sale. (See Appendix C, Section C, para. 4 in this Bulletin).

† Coconut "milk" is well known also as an accompaniment to "gula malacca". It is frequently used by ice-cream manufacturers in Malaya at the rate of 10 coconuts to each kerosine tin of ice-cream mixture, prior to freezing.

Our investigations on coconut milk as a culture medium are briefly as follows:

The inside of a freshly opened coconut contains no viable bacteria. On preparing coconut milk, however, the ingredients are immediately given, from the hands and the utensils, a bacterial content of about 50,000 viable organisms per c.c.m. "B. coli" being present in 1/100 c.c.m. It is an excellent culture medium, and after a few hours (during which the introduced bacteria multiply at room temperature) the "milk" may contain some millions of organisms per c.c.m. After 24 hours, however, at room temperature, it often becomes sour, and the acid then formed is antagonistic to the further life of some organisms such as *B. typhosum*. If, however, the product is refrigerated before it turns sour, *B. typhosum* is thus kept alive for many days.

Of all the various ingredients used in Malayan hawkers' ice-cream, coconut milk is thus considered, bacteriologically, the most dangerous.
Further, despite the modernity of his freezing plant, the water supply in the shop-house where he had set up his "factory" was inadequate. He, therefore, for supplying the room in which he made ice-cream, fitted a rubber hose to the only downstairs water tap which was situated over the kitchen drain. This drain was, as is common in shop-houses, used as a slop sink and urinal. When water for the ice-cream "factory" was not required, or when the kitchen tap was used for domestic purposes, the detached end of the rubber hose lay in this highly contaminated kitchen drain. (See photographs 8, 9 and 10.)

Water for making ice-cream and mixing the coconut milk was obtained by picking out the rubber hose from the drain and slipping it over the kitchen tap which, when turned on, sluiced the dirty drain water within the hose into the ice-cream mixture. This maker's ice-cream when examined teemed with living bacteria (two million per c.cm.) and the wide range of microscopic flora included organisms, presumably from the bowel, even in 1/100,000 c.cm. which was the smallest volume tested. His plant included a very efficient storage refrigerator in which he could keep his ice-cream from turning sour for a week or ten days. This good refrigeration was actually more favourable for preservation of his typhoid bacilli, which at higher temperatures would have been killed by souring changes in the ice-cream, and which were likely to have perished in the more intense struggle for bacterial existence occurring at higher temperatures. It was found that typhoid bacilli, when added to samples of his ice-cream and kept under his conditions of refrigeration, only suffered decline and death between the sixteenth and nineteenth day, by which time the ice-cream was too sour for sale.

All the manufacturing conditions described above are not uncommonly encountered if ice-cream plants are set up in shop-houses in Malaya. Water taps are frequently inadequate.

If the proprietor or his helpers happen to be typhoid carriers we have the unfortunate triple concatenation of:

(i) Typhoid carrier.

(ii) Intimate handling of an uncooked food which contains a good culture medium for bacteria and which is widely distributed in small quantities.

(iii) Preservation of typhoid bacilli in the food by refrigeration.

In this particular case there also occurred a triad of unusual (and unfortunate) circumstances, as follows:

(i) The obtaining by this man of the monopoly of ice-cream making for the town and district. (This, at first sight, seemed highly desirable as permitting readier sanitary control).

(ii) The rare type of typhoid bacillus harboured by this "Typhoid carrier", for his "dwarf colony" strain of the typhoid bacillus* seemed ill-adapted to growing on laboratory culture media and could readily have escaped notice.

(iii) Finally, the "red herring" drawn across the trail of investigation by the discovery of suspicious Widal reactions among two hawkers attending schools, one of whom was selling the ice-cream in question. As mentioned, neither of these hawkers was a typhoid carrier.

The six factors mentioned combined together to give rise to an epidemic which was, however, later prevented from becoming much more widespread by unremitting and well-directed efforts by the already over-worked Health Authorities. They had,

during earlier months, already prevented other epidemics arising from two other hawkers who were typhoid carriers. It was remarkable that this State should have been so beset at this period by "typhoid carriers" who were food hawkers, but it may here be noted that two of them (including the ice-cream manufacturer) were very recent migrants from another State where typhoid had been prevalent.

Epidemics of typhoid fever have occurred in larger towns in Malaya previously and in two of them, ice-cream has been suspected. If, however, in the past, the proprietor or the workers in the suspected ice-cream factory have been found at the height of the epidemic, or later, to be excreting typhoid bacilli—or else to have had suspicious Widal reactions, it has then been difficult to say whether (i) these ice-cream workers had been typhoid carriers from the beginning or (ii) whether they had, along with others, acquired their infection during the epidemic and thus have had no part in starting it.

In the epidemic described above, however, the ice-cream manufacturer was known to have a highly suspicious Widal reaction months before the epidemic started, and long before he was able to commence manufacture. When he began to distribute his product the epidemic started. When he was removed it ceased. He was also a fairly constant excretor of typhoid bacilli (5 out of 7 occasions). It is considered that the findings presented above constitute the fullest evidence yet available in Malaya of an epidemic of typhoid fever caused by ice-cream infected during its manufacture.

Notes:
The experiences detailed above serve to lay emphasis on certain points, some of which are advanced as follows:

(i) Piped water supplies in Malaya are often more liable to pollution at their termination than at their source (but preventive measures, are, of course, more readily concentrated on the source of supply than on the diffuse terminal reticulum of small pipes). In the case cited above, contamination of the house supply was brought about within the dwelling because makeshift rubber hose connections were used. This practice is frequent.

(ii) Among the various ingredients used in making ice-cream in Malaya, coconut "milk" is probably the most efficient vehicle of typhoid infection. In properly refrigerated ice-cream, Malayan strains of typhoid bacilli will remain alive for more than two weeks.

(iii) During a typhoid epidemic the search for typhoid carriers becomes a matter of extreme urgency and importance. "Suspicious" or positive Widal reactions, however, may confuse the issue to a serious degree unless skilled bacteriological examination of feces and urine is available. (See Appendix B.)

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APPENDIX A.

THE MANUFACTURE OF ICE-CREAM "POTONG" IN A SHOP-HOUSE FACTORY.

The account which follows refers to the making of ice-cream in a shop-house by the typhoid carrier mentioned in the foregoing report. His methods are regarded as representative of his fellow manufacturers. Full details are therefore given. These are thought to be of some interest to Health Officers:

(i)—INGREDIENTS USED IN MAKING ICE-CREAM.

The ingredients used are mostly of local origin. They are as cheap as is consistent with popular taste and reasonable profit. Ingredients are detailed in tabular form as follows:
Ice-cream Ingredients.

Ingredient. | Proportion used to every kerosine tin (4 gallons) of ice-cream.
--- | ---
(i) Tinned milk (Sweetened condensed) | 3 tins
(ii) Coconut “milk” (extract) | Flesh from 10 coconuts squeezed with tap water
(iii) Sago (“ubi sagu”) | About 2 lbs.
(iv) Sugar (white) | About 18 lbs.
(v) Corn flour (tinned imported) | About 1/2 lb.
(vi) Margarine | About 1/2 lb.
(vii) Flavourings: either cocoa, roasted and ground “kachang merah”, or vanilla essence may be used | Sufficient quantity

(ii).—Processes in Making Ice-Cream.

(a) Sugar is added to water and boiled, thus making a syrup.

(b) The sago flour, the corn flour and the margarine are then made into a paste and added to the syrup.

(c) The syrup and paste mixture, after heating, is then put in a kerosine tin, thickened by heat and allowed to cool until the same evening or next day.

(d) The tinned condensed milk and the coconut milk* are then added to the syrup and paste mixture which is well stirred until it is more liquid.

(e) Flavourings are then added. If the bars of ice-cream (ice-cream “potong”) are required the fluid mixture is poured into moulds which are then immersed in a brine freezing tank. (See photographs).

Appendix B.

Improved Culture Methods: (a) In the Search for Typhoid Carriers, and (b) In the Isolation of Dysentery Bacilli.

Technical efficiency in culturing _B. typhosum_ assumes great importance during a typhoid epidemic when much may depend on the rapid detection of carriers. The search for typhoid bacilli in excreta may, however, be likened to looking for a needle in a haystack. For constant success in infective cases, and to ensure the reasonable reliability of negative reports, bacteriological technique must be of a consistently high order.

The first step towards isolation consists in inoculating the excreta into a fluid culture medium designed to retard the multiplication of non-pathogenic bacteria, and to encourage the growth of _B. typhosum_. This medium thus exercises a “selective” effect and, after incubation, it is inoculated on to a solid agar medium devised to have further selective action. The solid medium contains “indicator” substances and dyes, so that any bacterium of the typhoid group forms colonies of characteristic and distinctive appearance. Likely-looking colonies are then “picked off” from the culture plates and subjected to confirmatory tests.

Different chemical substances may be used in agar media as “colony indicators”, and for producing a “selective” effect. Although most bacteriologists work along the same general lines, a variety of culture media are used in different countries. It is thus unavoidable that considerable variation in success is reported from different laboratories in the isolation of _B. typhosum_ from excreta. In considering such results, however, it is to be remembered that not all enteric cases excrete _B. typhosum—the condition being primarily a bacteriemia with secondary infection of the mucosa of the bowel. The success of excretal culture also depends, among other factors, on the period after onset when specimens are taken.

* It is noteworthy that the coconut milk, usually having a very high bacterial content (in this man’s case, 8 million organisms per c.cm.) is always added last and just prior to freezing the mixture.
The following tables show some of the variations mentioned:

**TABLE I.**

Variations in the Success Rate for Isolating *B. typhosum* from Miscellaneous Specimens of Feces, including Known Enteric Cases (and Repeated Specimens therefrom), Typhoid "Contacts", Food Handlers, Suspected Carriers, etc.

<table>
<thead>
<tr>
<th>Laboratory</th>
<th>Country</th>
<th>Proportion of Successes.</th>
<th>Proportion</th>
<th>Per cent.</th>
<th>Proportion</th>
<th>Per cent.</th>
<th>Total successes</th>
<th>Variations in &quot;percentage positive&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Malaya</td>
<td>Not known</td>
<td>Not known</td>
<td></td>
<td></td>
<td></td>
<td>32/3283</td>
<td>1.0 %</td>
</tr>
<tr>
<td>B</td>
<td>&quot;</td>
<td>37/920</td>
<td>4.0</td>
<td></td>
<td>2/207</td>
<td>1.0</td>
<td>18/1440</td>
<td>1.3 %</td>
</tr>
<tr>
<td>C</td>
<td>&quot;</td>
<td>163/764</td>
<td>21.4</td>
<td></td>
<td>16/908</td>
<td>1.7</td>
<td>179/1732</td>
<td>10.3 %</td>
</tr>
<tr>
<td>D</td>
<td>India</td>
<td>Not known</td>
<td>Not known</td>
<td></td>
<td></td>
<td></td>
<td>0/221</td>
<td>0 %</td>
</tr>
<tr>
<td>E</td>
<td>&quot;</td>
<td>2/2285</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3/2285</td>
<td>0.13 %</td>
</tr>
<tr>
<td>F</td>
<td>&quot;</td>
<td>10/565</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5/163</td>
<td>3.0 %</td>
</tr>
<tr>
<td>G</td>
<td>Africa</td>
<td>&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>26/760</td>
<td>3.4 %</td>
</tr>
<tr>
<td>H</td>
<td>China</td>
<td>&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13/223</td>
<td>5.8 %</td>
</tr>
<tr>
<td>I</td>
<td>&quot;</td>
<td>132/560</td>
<td>23.4</td>
<td></td>
<td>5/163</td>
<td>3.0</td>
<td>179/1732</td>
<td>10.3 %</td>
</tr>
<tr>
<td>J</td>
<td>Australia</td>
<td>&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0/221</td>
<td>0 %</td>
</tr>
</tbody>
</table>

**TABLE II.**

Variations in Success in Isolating *B. typhosum* from Feces of Known Enteric Cases—Excluding all Repeated Specimens.

<table>
<thead>
<tr>
<th>Laboratory</th>
<th>Proportion of typhoid cases feces positive</th>
<th>Percentage positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>76/275</td>
<td>28.0%</td>
</tr>
<tr>
<td>C</td>
<td>26/345</td>
<td>7.5%</td>
</tr>
</tbody>
</table>

As research in bacteriological chemistry progresses, better "selective" and "indicator" chemicals are found, and *B. typhosum* is then more readily isolated. Promising new culture methods have always been given a fairly extensive trial at this Institute, but there has often been reversion to the well-tried combination of Teague and Clurman's 30 per cent. glycerine solution, and eosin-methylene-blue agar and/or MacConkey's agar. However, preliminary incubation in Leifson's sodium selenite medium has proved of distinct advantage. This medium consists of a phosphate-buffered peptone and lactose solution containing 0.4 per cent. sodium selenite; the latter exercises an inhibitory effect on *B. coli* while encouraging the growth of *B. typhosum*.

**THE PRELIMINARY INCUBATION OF TYPHOID EXCRETA IN SELENITE MEDIUM.**

Specimens of feces (550) and of urine (518) were cultured in parallel: (a) by direct plating on various media, and (b) on similar media after twenty-four hours
preliminary incubation in selenite medium. The results are briefly as follows:

**Table III.**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Direct selenite</td>
<td>Direct selenite</td>
<td>Total positive</td>
</tr>
<tr>
<td>i. Faeces: 451</td>
<td>Typhoid convalescents</td>
<td>67</td>
<td>43</td>
<td>8*</td>
</tr>
<tr>
<td>ii. Faeces: 99</td>
<td>Suspected carriers</td>
<td>6</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>iii. Urine: 424</td>
<td>Typhoid convalescents</td>
<td>24</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>iv. Urine: 94</td>
<td>Suspected carriers</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

From these results it was concluded that sodium selenite medium offers distinct advantages in searching for *B. typhosum* in faeces, and the medium has been adopted for routine use.

**SODIUM DESOXYCHOLATE CITRATE AGAR IN CULTURING AND SELECTING COLONIES OF *B. TYPHOSUM.*

This medium contains sodium desoxycholate§, lactose, ferric ammonium citrate and sodium citrate with neutral-red as an indicator dye. Specimens (either incubated previously in sodium selenite medium or without preliminary selective treatment) were cultured in parallel: (a) on this new medium, and (b) on eosin-methylene blue medium. In all, 791 specimens of faeces and 750 specimens of urine—practically all from typhoid contacts, food handlers, and suspected carriers—were examined.

**Table IV.**

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Faeces: 791</td>
<td>24</td>
<td>13</td>
<td>40</td>
<td>13/40</td>
<td>3/40</td>
</tr>
<tr>
<td>Urine: 750</td>
<td>7</td>
<td>0</td>
<td>1</td>
<td>8</td>
<td>None</td>
</tr>
</tbody>
</table>

* Due mainly to overgrowth of *B. proteus* on eosin-methylene blue culture medium. This bacterium swarms over and obscures other colonies and appears to be encouraged by incubation in selenite (Incidentally, selenite appears to interfere with the growth of dysentery bacilli.)

† In this series, five additional "carriers" were detected by the use of selenite medium.

‡ In culturing urine for *B. typhosum*, little advantage (4 per cent. only) was gained by the use of selenite medium. If a specimen of urine contains *B. typhosum*, it usually shows a fairly profuse and pure growth on direct culture.

§ The effect of sodium desoxycholate on the growth of bacteria is similar to ox-bile but is said to be more powerful. The composition of the bile of animals varies; chicken bile is rich in cheno-desoxycholate. The citrate in this medium inhibits the growth of some of the members of the "*B. coli*" group. Desoxycholate citrate medium may be inoculated much more heavily with faeces, thus increasing the chances of isolating pathogenic organisms that may be present.
Due to the sources of the specimens tested, the positive results were relatively few. The desoxycholate citrate medium, however, gave 25 per cent. more positive results with feces than did eosin-methylene blue—an important gain in "typhoid carrier" investigations.

The medium has certain technical and other disadvantages as compared with eosin-methylene blue. For example, the former is somewhat more difficult to prepare, costs about three times as much, and gives rise to many more clear and undifferentiated colonies of "non-pathogens". More extensive picking of colonies is thus required. Although it prevents the spreading of B. proteus with the consequent obscuring of colonies that occurs occasionally on eosin-methylene blue medium, the resulting non-spreading colonies often look highly suspicious, and many may be picked off in mistake for B. typhosum or other pathogens. On this medium there develops a higher proportion of colonies resembling those of the pathogenic salmonellas but which are later found to be indologenic and almost certainly non-pathogens. Such organisms seem to be largely suppressed on eosin-methylene blue medium.

THE USE OF SODIUM DESOXYCHOLATE CITRATE AGAR IN THE SELECTIVE CULTURE OF DYSENTERY BACILLI.

Unless stools from dysentery cases are "plated" within a short period after evacuation, the causal organisms appear rapidly to be overwhelmed by the non-pathogens and to die. Dysentery bacilli also appear to be more sensitive than enteric organisms to the "selective" and "indicator" substances commonly used in culture media. Some observers have expressed doubt regarding the ability of dysentery bacilli, other than B. dysenteriae (Flexner), to grow well on Sodium Desoxycholate Citrate Agar. But, on the contrary, the Sonne dysentery bacillus (16 cases) and the Schmitz dysentery bacillus (1 case) have been isolated by us from primary "platings" from feces. To test this point further, stock cultures of other dysentery organisms such as "Shiga", "Dispar", "Alkalescens" and "Newcastle" have been seeded onto desoxycholate citrate plates. The relatively unimportant "Alkalescens" and "Dispar" did not grow well, but "Shiga" and "Newcastle" showed profuse growths.*

A table showing the results of the primary platings follows:

**Table V.**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(Flexner) 79</td>
<td>(Flexner) 60</td>
<td>(Flexner) 4</td>
<td>56/143</td>
<td></td>
</tr>
<tr>
<td>(Sonne) 10</td>
<td>(Sonne) 6</td>
<td>(Sonne) 1</td>
<td>5/17</td>
<td></td>
</tr>
<tr>
<td>(Schmitz) 1</td>
<td>(Dispar) 1</td>
<td>(Dispar) 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>90</strong></td>
<td><strong>66</strong></td>
<td><strong>9</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>57/165</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Some American workers† have recommended the preliminary incubation of suspected fecal material in a broth containing sodium desoxycholate and citrate in buffered saline; they claim superior results from this method. Specimens (198) have been cultured in parallel, with and without incubation in the desoxycholate broth. This method has been found a failure for, using E.M.B. agar medium, 19 Flexner and two Sonne positives were lost through putting the fecal material into the broth. Similarly, with sodium desoxycholate citrate medium agar for plating, 22 Flexner and two Sonne positives were lost by preliminary culture in this special broth.

* It is of interest that V. cholerae did not flourish on desoxycholate medium. For this, MacConkey's bile salt agar has been found superior to Diendonné's or Goldberger's medium.
† Banxgang and Eliot, Am. Jl. Hyg., XXXI, 16.
A sound "universal" culture medium would be a great boon in the tropics—a single medium on which would grow readily and with good differentiation, colonies of the "typhoid-salmonella" group, dysentery bacilli and cholera vibrios. Unfortunately, no one culture medium has yet been devised to meet these requirements.

APPENDIX C.

RELEVANT EXTRACTS FROM VARIOUS SOURCES.


"No hawker's licence for the sale of ice-cream was issued until the applicant had arranged to obtain supplies from a manufacturer approved by the Health Officer. The source of supply in the case of each hawker was endorsed on the licence.

Owing to the marked prevalence of typhoid fever, and probably of carriers, the difficulty of obtaining information of cases or enforcing isolation, the migratory habits of the people and the ignorance of such a large proportion of the population as to the ways and means by which typhoid infection may be spread, it was decided that no ice-cream should be approved for sale by hawkers, unless the 'mix' was pasteurised and then conveyed, without risk of contamination, through the many stages of manufacture to the finished product. This necessitated the use of a pasteuriser, and a plant which provided for steam sterilisation, in situ, of all the internal surfaces of the connecting pipes, cooler, freezer, etc. The finished product had then to be wrapped up at the factory before it was issued for sale by the hawkers.

At the moment there are two factories in Singapore which have the plant necessary to produce an ice-cream which meets with our approval for sale to hawkers, and thence to the public.

I may add that from a practical point of view it has been shown time and again that a safe ice-cream of an exceedingly satisfactory bacteriological standard can be produced in Singapore by means of such a plant as previously mentioned, provided that adequate supervision is exercised and the plant is properly used and cared for.

If it were possible to lay down a bacteriological standard for ice-cream in Singapore it would prove of great value in that it should serve as an effective means of ensuring the maintenance of a high standard of bacterial purity of the ice-cream approved for sale by hawkers. Such a standard can be constantly maintained only so long as the plant used in the process of manufacture is properly cared for and run under efficient and careful supervision.

With regard to shops and other places, which, though having no licence for the preparation of ice-cream, make it for consumption on the premises or for direct sale to the public, it has not been found possible to do anything to date.

When the question was discussed as to what steps, if any, were desirable to control the preparation and sale of ice-cream in such shops and other places, many difficulties arose.

The Commissioners decided that it was not desirable or justifiable to insist on these shops and places either providing somewhat similar plants to those approved, by us for the manufacture of ice-cream for sale to hawkers, or else obtaining all their supplies from a source approved by us, as in the case of hawkers, and suggested the possibility of drawing up modified requirements instead. In view, however, of certain legal difficulties which arose, the matter had to be held in abeyance.

With a plentiful public water supply, above suspicion and a milk supply 90-95 per cent. tinned, undoubtedly ice-cream is the most potentially dangerous means of dissemination of massive typhoid infections in Singapore, as the ice-cream 'mix' is an almost ideal culture medium for the rapid growth and multiplication of the typhoid organisms. Other, though less, important, means of typhoid dissemination as they are not such good culture media for typhoid organisms, remain to be dealt with, e.g., iced water, ice balls, etc., but nothing further can be done until certain legal difficulties have been overcome."