STUDIES ON THE BACTERIOLOGY OF HYPOPYON ULCER

II.—The Conjunctival Flora of Shale Mine-workers

BY

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Introduction

THE work reported in this paper is a direct continuation of my previous study on the conjunctival flora of coal mine-workers (Rhodes, 1938). The object of this work is to elucidate the aetiology of hypopyon ulcer, especially in miners. An examination has been made of some 187 shale mine-workers in two different pits in central Scotland. The examinations were carried out in the months of October and November.

The working conditions in these two shale mines are almost identical, and differ greatly from those in the coal mines which I have visited. The manner of working shale is as follows. The shale is blown out of the seam by explosives, and the miner then hews out the pieces dislodged by the explosion with a pick. The shale is loaded into hutches which are transported by the oncost-workers to the main haulage roads. These roads, as well as the hewing places (stoopings), are high and airy. The whole working conditions are clean and relatively free from dust.

Methods

As before, the workers were examined at the pit head as they came off their shift. Screw-topped bottles of blood agar were used and examined for growth as in the previous study.

There are only three main classes of shale worker: surface, oncost, and miner. No difficulty was experienced in examining sufficient numbers of oncost-workers and miners, but owing to the relatively few men employed some difficulty was experienced with the surface workers. Ultimately it was decided to fuse the results of the examinations of surface workers from the two pits, thus giving the usual total of 40. The surface men comprised the usual mine labourers and skilled tradesmen, as well as men employed in "tumbling the shale" out of the hutches.

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Results

Organisms isolated. *Staphylococcus albus* and diphtheroid bacilli.—These organisms were isolated with considerable frequency. The presence of the organism is noted only if it occurred in moderate or profuse amount (see Tables II and III). The results are of the same order as previously reported in coal miners. It would appear as if these organisms occurred with greater frequency at the D mine than at W.

Other commensals.—*Staphylococcus citreus*, anthracoids, *micrococcus tetragenus* and *micrococcus catarrhalis* were isolated on occasions, but little importance need to be placed on their occurrence.

Pathogens.—Table I shows the percentage of the various pathogenic organisms isolated from shale workers, compared with the findings in coal-workers.

Alpha cocci.—The table (I) shows a slightly lower percentage of alpha cocci than in coal workers. These organisms were tested for their ability to produce green pigmentation on boiled blood, for their bile solubility, and inulin fermentation. Cultures suspected to be pneumococcal were injected into mice and typing carried out. Strains proving bile insoluble and not fermenting inulin were classified as *streptococcus viridans*, and were isolated in a lower percentage of persons than in coal mines.

Pneumococcus.—Group 4 pneumococcus was isolated from a slightly higher percentage of shale than coal workers. Only 2 of the 18 strains were visible in the mouse peritoneal exudate after 24 hours. Neither of these reacted to type sera 1, 2, or 3. These findings parallel those in coal workers where the majority of strains were avirulent and untypable.

TABLE I
Showing the percentage of Coal Workers and Shale Workers
harbouring various pathogenic organisms.

	Coal	Shale
	per cent.	per cent.
Total alpha cocci - - - - -	19·35	16·43
<i>Streptococcus viridans</i> - - - - -	11·25	6·89
<i>Pneumococcus</i> - - - - -	8·1	9·54
<i>Diplobacillus of Morax</i> - - Pit A Others	6·76 2·3	1·59 —
Haemophilic bacilli - - - - -	1·5	1·06
<i>B. Coli</i> - - - - -	0·75	2·65

Eleven of the 18 strains (61·5 per cent.) gave the classical reactions of the pneumococcus while the remainder (38·5 per cent.) fermented inulin, but proved bile insoluble. It will be recalled that bile insoluble strains were also encountered in coal workers.

Diplobacillus of Morax.—At first sight this figure appears lower than that in coal workers. When analysed, however, all the strains were found to occur in miners, giving a figure of 5 per cent. at mine D and 2·5 per cent. at W. Shale miners therefore harbour the organism with approximately the same degree of frequency as coal miners.

Other pathogens.—Haemophilic bacilli and *B. coli* were also isolated and the *B. coli* figure was seen to be higher in shale workers.

Individual mines.—*Mine D (Table II)*.—The important point to note is that the miner evidently harbours a significantly higher percentage of alpha cocci (especially pneumococci) and *diplobacillus of Morax* than the other workers. Further, it will be seen that D workers show a higher percentage of organisms generally than do W workers. This is of some interest, as the conditions

TABLE II
Showing percentage D Shale Mine-Workers harbouring various organisms.

	Miners	Oncost	Surface
Total number examined - - -	40	40	40 (both pits merged)
ORGANISMS GROWING IN PROFUSE OR MODERATE AMOUNT.			
<i>Staphylococcus albus</i> - - -	40	40	32·5
Diphtheroid bacilli - - -	62·5	42·5	35
ORGANISMS GROWING IN ANY AMOUNT.			
<i>Staphylococcus citreus</i> - - -	7·5	7·5	2·5
<i>Staphylococcus chromogenicus</i> - -	—	—	—
<i>Streptococcus viridans</i> - - -	2·5	5·0	12·5
<i>Pneumococcus</i> (group 4) - - -	20	10	5
<i>Pneumococcus</i> (type 1, 2, or 3) - -	—	—	—
<i>Diplo-bacillus of Morax</i> - - -	5	—	—
<i>Micrococcus catarrhalis</i> - - -	—	—	—
Haemophilic bacilli - - -	—	—	2·5
Anthracoïd bacilli - - -	—	2·5	—
<i>B. coli</i> - - -	2·5	5	—

α cocci

of work were very closely similar. *Mine W (Table III).*—The figures in this mine are lower than those for mine D for the majority of organisms. W miners, however, do not have a higher percentage of alpha cocci than other workers, rather their figure is lower.

TABLE III
Showing percentage of W Shale Mine-Workers harbouring various organisms.

	Miners	Oncost	Merged Surface
Total numbers examined	40	27	40 (both pits)
ORGANISMS GROWING IN PROFUSE OR MODERATE AMOUNT.			
<i>Staphylococcus albus</i> -	15	33·3	32·5
Diphtheroid bacilli -	25	37	35
ORGANISMS GROWING IN ANY AMOUNT.			
<i>Staphylococcus citreus</i> -	2·5	—	2·5
<i>Staphylococcus chromogenicus</i> - - -	—	—	—
<i>Streptococcus viridans</i> -	7·5	7·4	12·5
<i>Pneumococcus</i> (group 4)	5	7·5	5
<i>Pneumococcus</i> (type 1, 2, or 3) - - -	—	—	—
<i>Diplo-bacillus of Morax</i>	2·5	—	—
<i>Micrococcus catarrhalis</i>	5	—	—
Haemophilic bacilli -	—	—	2·5
Anthracid bacilli - -	—	—	—
<i>B. coli</i> - - - -	2·5	3·7	—
<i>Micrococcus tetragenus</i>	5	—	—

Discussion

A wide range of organisms has thus been isolated from shale workers, as it was from coal workers. With regard to the pathogenic organisms there would not seem to be any important difference between coal and shale workers. Those exposed to most risk of traumatism, the miners, harbour alpha cocci and *diplobacillus of Morax* in significant quantity. Shale oncost-workers do not appear to harbour *diplobacillus of Morax*, although this was found regularly in coal oncost-workers.

The tendency for organisms to spread throughout a unit was observed in shale workers as in coal workers. Thus, only 7 strains of bile insoluble, inulin fermenting pneumococci were found in the two pits examined. Yet of these 7 strains 6 occurred in the miner group.

Further, it should be noted, on a larger scale, that the D workers harboured a more profuse flora than the W men, although the working conditions appeared identical.

Shale mine workers therefore harbour a flora consisting partly of potential pathogens. This fact is of most importance in those most exposed to traumatism. A spicule of shale entering the miner's cornea may afford the necessary breach of surface for these organisms to enter and cause infection. The opinion is again expressed that the source of infection in hypopyon ulcer is from organisms already present in the conjunctival sac, and that the mine worker's conjunctival flora definitely exposes him to the risk of infection.

Summary

1. The conjunctival flora of 189 shale workers has been examined.
2. Shale workers harbour significant quantities of potential pathogens such as *streptococcus viridans*, *pneumococcus* (group 4), *diplobacillus of Morax*, haemophilic bacilli and *B. coli*.
3. The evidence adduced is additional support for the belief that the source of infection in hypopyon ulcer is already present in the conjunctival sac, and that the mine worker's conjunctival flora definitely predisposes him to infection.

REFERENCE

RHODES, A. J.—*Brit. Jl. of Ophthalm.*, January, 1939.

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