IRRIGATION AND MALARIA.[1]

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Irrigation and malaria have been related terms ever since the health of the people became a subject of governmental and scientific interest and much has been written about it by a long series of eminent malariologists. In a meeting such as this, a review of these previous findings and theories is not necessary so this short paper will concern itself only with those aspects most familiar to the writer, of this broad question of fundamental importance to the future of India.

In Mysore irrigation is employed extensively over the greater part of the State on what may be classed as three varying plans. First, minor irrigations of small acreage under tanks depending on a capricious rainfall for their water supply ; second, larger irrigation projects from greater tanks which seldom or never go dry and distribute water through a fairly extensive system of larger or smaller canals ; third, extensive river irrigations covering a large acreage, with a perennial water supply distributed by large main canals and miles of subsidiary channels. The first type is usually only mildly malarious if at all, the second frequently malarious, and the third invariably malarious. Probably the best way to demonstrate these differences is to give a series of spleen indexes in areas representative of the various types of irrigation (*vide* Table 1).

In certain representative areas of Mysore, in which the source of any malaria can be quite definitely limited to one set of conditions, spleen indexes as related to small irrigations vary from 5·3 to 13·2 per cent, whereas in areas with extensive tank irrigations the indexes vary from 11·8 to 89·4 per cent. The riverine systems of irrigation all show high splenic indexes and this is true whether the system is an ancient one, as that around Nagenhalli, more modern as in Hiriyur (Sweet, 1933), or entirely new. There seems no natural tendency for malaria to die out in these riverine systems and, in Mysore, the disease appears as an epidemic immediately after the irrigation water is turned on in new systems. An instance of the epidemic and the endemic malaria conditions produced by new irrigation projects was offered by the Irwin Canal project in the Mandya Area of Mysore.

For some years the Public Works Department of Mysore was occupied in building a dam across the Cauvery River near Mysore City, from which the

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TABLE I.

Spleen Indexes in Children in Areas of Mysore State Representative of Various Types of Irrigation.

Area.	Small Irrigation under Tanks.	Large Irrigation under Big Tanks.	Riverine Irrigation.
Tumkur District—			
Gubbi Area	5·3	....	....
Thavarakere	....	54·8	....
Kunigal	....	11·8	....
Chitaldrug District—			
Chellakere Area	13·2	....	....
Jagalur Area	5·6	....	....
Hiriyur	....	....	69·9
Kadur District—			
Sakrepatna Area ..	....	57·6	....
Mysore District—			
Mandya Area	9·4	....	....
Yedadore Area	....	....	31·8
Chamarajnagar Area ..	6·4	....	....
Seringapatam	....	....	65·3
Shimoga District—			
Sulekere Area	....	89·4	....
Hassan District—			
Gorur-Arkalgud Area ..	....	....	57·9

Irwin Canal was to take water to irrigate some 120,000 acres in the Mandya Area. The main canal and three of its branches were completed in 1932 and in June of that year some 50,000 acres received their first supply of water. This area had been a comparatively dry one with numerous village tanks under which small irrigated areas existed without producing much malaria, the average spleen index of 33 of these villages being in the neighbourhood of 9·4 per cent before the new irrigation began.

Following the usual methods of irrigation engineers, water was supplied in excess and no provision had been made for drainage so that by the end of the year complaints of malaria began and in 1933 there prevailed an extensive epidemic. Admittedly the reporting of deaths in such rural areas is inaccurate but the reports received and filed are of interest in showing the results of this new experiment in irrigation. Table 2 gives the numbers of deaths in three rural areas in which the great majority of the villages were included in the irrigated acreage and in one area in which less than five per cent of the villages were so situated.

TABLE 2.

Numbers of Reported Deaths by Years in Four Rural Areas of Mysore as Related to Riverine Irrigation.[1]

Area.	1930.	1931.	1932.	1933.	1934.	1935.
Kasaba Hobli— 95% of villages within irrigated area.	122	118	280	209	271	378
Dudda and Kothathi Hoblis— 60% of villages within the irrigated area.	268	256	375	379	487	308
Basaral Hobli— Less than 5% of villages within irrigated area.	96	99	99	90	110	67

Death-rates were not figured for these areas due to the great inaccuracy of the reporting and it would not be wise to compare one area to another too closely, but the general trend of events is well demonstrated by the reports. In the Hoblis in which most of the villages were in the irrigated area, the number of reported deaths increased markedly in 1932 to reach a peak in 1933 or 1934, whereas in the adjacent Hobli in which the great majority of villages were not affected by the irrigation the numbers of reported deaths were fairly constant throughout.

The spleen indexes of the 33 villages previously mentioned bear out the picture presented by the reported deaths in that whereas the spleen index averaged 9·4 per cent before irrigation, it was 52·7 per cent in 1933 and 1934 and, in four of the villages which have been studied more thoroughly, was still at 31·7 per cent in April, 1937. That the original epidemic has settled down into what promises to be a permanent endemic condition would seem to be confirmed by this spleen index and the corresponding parasite index of 17·1 per cent in October, 1936.

To round out the picture it may be mentioned that blood films showed a great preponderance of *Plasmodium vivax* and that *A. culicifacies* was the only anopheline found carrying, 3·2 per cent of this species showing infection (Nursing, Rao and Sweet, 1934).

DISCUSSION.

Represented in Mysore, then, are three types of irrigation tracts, one of which is mildly malarious, another more heavily so, and the third invariably heavily malarious, the latter riverine type showing not only an initial epidemic

[1] Irrigation water first turned on in June, 1932.

but also a later endemic condition in which there is no natural tendency to diminish even in systems well over a century old. Considering these three types there would seem to be three points which may explain the differences in the malarial conditions found to exist in association with them. These are (1) the length of main and subsidiary channel; (2) the amount of water used; (3) the season of the year in which water is available.

The riverine type of irrigation is characterized by miles of main and subsidiary channels, a feature which never is found in small, village irrigations under tanks, and may or may not be present in the larger tank irrigations. Not only is this dangerous in itself (in places where *A. culicifacies* and members of the *A. fluviatilis* group are the carriers), but the malariologist is also concerned with the numerous seepages and overflows from these channels. His problem in this connection is to find some method of preventing the inevitable breeding of the dangerous species in channels and to deal adequately with the seepages.

A striking difference between these three types of irrigation systems is in the amount of water available for use. In the smaller type water is scarce and treated with great respect, whereas in the larger tank system, not so subject to failure due to one bad season, it is more abundant and is found to be wasted to a greater extent. The larger riverine system, however, is pre-eminent in this respect and apparently no attention whatever is paid to conservation or proper use of water in such areas. Water flows continuously in a tremendous over-supply and is found all over the area, very frequently running to waste completely due to the various farming requirements of the cultivators on the branch channel. It seems possible that in this question of the use and waste of water may be a key to the solution of the question of malaria control in irrigated areas. There are always objections to the strict regimentation of the population and the extensive changes in agricultural customs which proper control of water would entail, but in the face of the history of the larger irrigation systems of India there would seem to be no need to hesitate in applying a test of the value of the method, not only for its possibilities in controlling malaria but also in its value to agricultural and monetary returns. Where water is so scarce and valuable as it is in India all interests, including those of the malariologist, would seem to call for its strict conservation.

The third point mentioned, that of the season of the year in which water is available is one which requires more study but in Mysore there would seem to be a quite direct relation between this factor and malaria. Where water is available only during the last six months of the year and all channels and fields are completely dry during the first six months there would seem to be a good chance to escape malaria. The emphasis here must be on the 'completely dry' as in systems in which water is turned into the main channels at intervals during the dry season, as in those in which water is available for cultivation throughout the year, malaria is a great problem. There is still not sufficient known in the tropics about malaria transmission seasons and

much further study is required by the malariologist before a definite statement can be made. However, it must be remembered that over great stretches of India (the parts most likely to be extensively irrigated), the presence of water in the usually hot and extremely dry season might completely reverse the accepted picture of malaria transmission.

The subject cannot be left without mention of drainage, a point in which all irrigation systems are equally lacking. When drainage is suggested the invariable answer is on the score of expense but not providing for the removal of water supplied not only results in lowered financial returns but also in malaria and from both standpoints drainage would seem justified. Just why an extensive irrigation system should be expected to repay its capital cost in a minimum number of years (at the expense of the efficiency of its operation and the health of its people), and in addition give Government a handsome return on its money, is one of those mysteries which ordinary mortals may not fathom.

In conclusion it is of interest to note the existence of a central board for research in irrigation problems of which apparently malaria is not considered to be one for, as far as the writer knows, no malariologist is on this board and malaria enters into its research programme only in a most remote way.

Summary.

There are three types of irrigation systems in Mysore State. One involves a small area under a local tank and is usually not malarious; a second covers a larger area under a bigger, more permanent tank and is frequently malarious, while the third is an extensive riverine system which is invariably malarious. This riverine system not only produces an initial epidemic of malaria, as was demonstrated by a history of events following the opening of the Irwin Canal system in June, 1932, but also is heavily endemic even after over a century of existence. The three types of irrigation seem to differ in (1) the length of main and subsidiary channels; (2) the amount of water used; (3) the season of the year in which water is available. In these three differences possibilities for the control of malaria exist, special emphasis being laid on the strict control of the amount of water supplied and its use. Lack of drainage remains as a defect common to all types but, due to expense, it does not seem likely that this aspect of the prevention and control of malaria in new and existing irrigation systems will receive the attention it deserves until the profit motive is largely removed from consideration.

References.

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