

ERRATUM.

The radiogram on p. 379 of the May number of the Journal should be inverted.

Journal
of the
Royal Army Medical Corps.

Original Communications.

A DISCUSSION ON MALARIA IN THE QUETTA-PISHIN
DISTRICT.

By MAJOR R. A. MANSELL, M.B.E.,

Royal Army Medical Corps.

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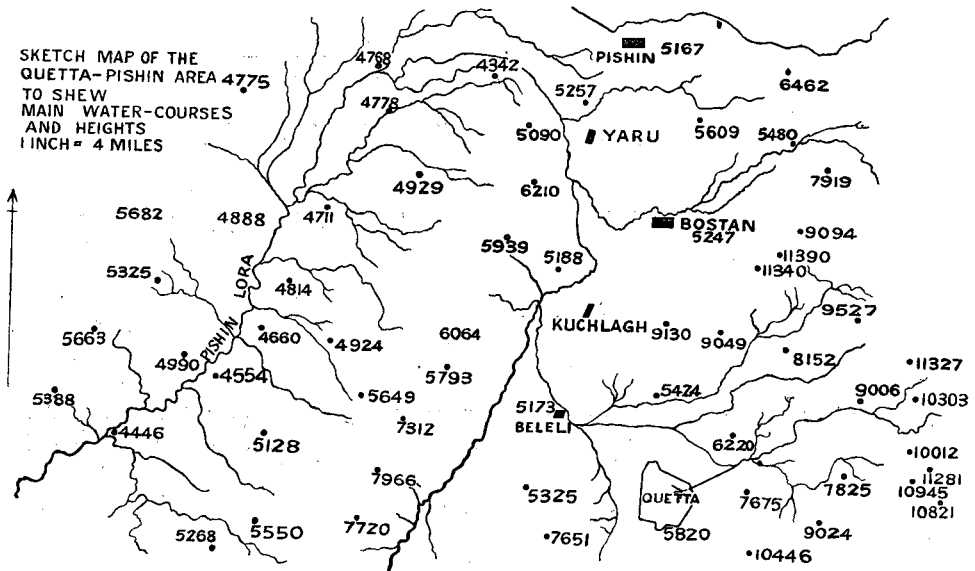
The meteorological data are taken from the Government of India's published records and reports.]

Quetta stands, at an average height of 5,500 feet above sea-level, in the mouth of a valley lying to the south-east of the Quetta-Pishin District. This district consists, broadly, of a series of more or less precipitous, barren mountain ranges which run north-north-east to south-south-west and enclose long alluvial valleys varying in width from two to twenty miles. The mountain ranges consist, each, of steep stony slopes rising rapidly to long spurred ridges of an average height of 7,000 to 8,000 feet, with occasional peaks reaching to over 10,000—the highest to 11,738—feet above sea-level.

Some miles to the north of Pishin, which itself is thirty-two miles by road from Quetta, the drainage slopes run towards Afghanistan; the great majority of the remainder of the district drains, via the Pishin Lora, in a south-westerly direction. A little to the north of Pishin the largely if not wholly

artificial lake of Khushdil Khan feeds an irrigation canal system towards the west. The Pishin Lora runs, for the most part, in a wide channel between deep banks; where possible this stream supplies irrigation water to the neighbouring country. From the Zarghun range, which rises some fifteen miles north-east of Quetta and contains the highest peak in Baluchistan, there flows the stream which supplies the drinking water of Quetta; this stream irrigates many fertile farms in the Hanna valley through which it passes finally to supply irrigation water to the cantonment, aided by the flow from subsidiary valleys.

Most of the remaining cultivated area in the district is immediately dependent on the winter rains and snow, and on the water obtained



from karez. These karezes are, in fact, underground irrigation channels. They are constructed and maintained, I understand, mostly by a class of people who follow this work as a hereditary occupation. The karez is started, I am told, from a point in the valley at which water outcrops, or appears likely to do so. From this point an ever-deepening channel, in ordinary cases some two feet broad at its base, is dug backwards towards the source of water in the hills. When the channel becomes too deep for its sides to support themselves, it is converted into a tunnel; this is constructed by the simple process of following the direction of maximal water flow along the base of the sub-soil level. At frequent intervals along the course of this tunnel shafts are sunk from the surface, both tunnel and shafts being, ordinarily, only sufficiently large to permit the passage of

Authors are alone responsible for the statements
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a man. Hands, ropes, wicker baskets or sacks and the crudest form of windlass are the implements of work; and only in the very largest karezes is any form of reveting or masonry to be found. The tunnel extends usually up to the origin of the true mountain from the foothill, and may be several miles in length. The shafts in Quetta of a karez which runs through the cantonment are nearly eighty feet in depth. Forming, as they do, the main sources of water for large tracts of country, these karezes are jealously guarded, valuable property; their owners possess no mean knowledge of the influence of proposed new tunnelling in the vicinity of the line followed by their own stream.

The climate of Quetta itself is rather more severe than that of the majority of the valleys which form the district. Pishin, for instance, is practically 500 feet nearer sea-level than Quetta; and the higher lands are occupied only in the warm weather by nomads. Chart I shows the figures given by the meteorological department as the "normals" for Quetta, and explains the matter more accurately and succinctly than any verbal description. A comparison of this chart with those for each of the four years given will show, however, that "quite exceptional" weather is as common in Quetta as elsewhere in the world. The outstanding features of the climate are, briefly, the large diurnal and annual variations of the temperature, the low rainfall and the relative humidity.

The soil, generally, is light and porous and, with a little care, is amazingly fertile. Natural vegetation, except in the immediate vicinity of the comparatively few permanent waters, does not occur. The winter rains and snow provide water for the crops, which, in favourable years, may be abundant, and also nourish the orchards. But the general aspect of the country during the greater part of the year is that of a place burnt dry by the sun, blown bare by the wind, and of an all-pervading sandy dust colour.

One of the most important results of all these factors is that, except in the permanently flowing channels—and these are few—water supplied for irrigation or other purposes disappears into the ground with amazing rapidity. An irrigation channel which has been running full for several hours will dry completely within an almost equal time after the flow has stopped; the same thing will occur even throughout the length of a fairly extensive road culvert, unless, of course, this is bricked or cemented. Quetta is a place where to cement the water channels is to handicap the anti-malaria worker; and the constant problems for such a person in Quetta cantonment itself are the bricked siphons carrying irrigation water under the main roads, a few areas in close relation to the main, continuously flowing, irrigation channel, the water supply reservoirs and—as ever—the taps which some leave permanently open in order to obtain the maximum value from their gardens.

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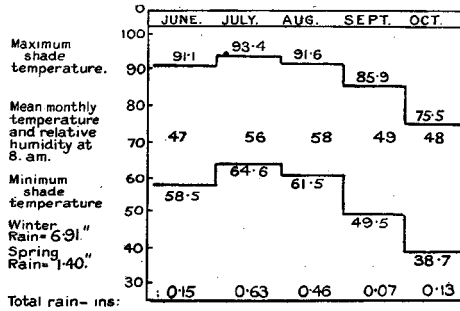


CHART I.

On the same scale as the following Charts, showing, diagrammatically, the mean monthly meteorological normals for Quetta.

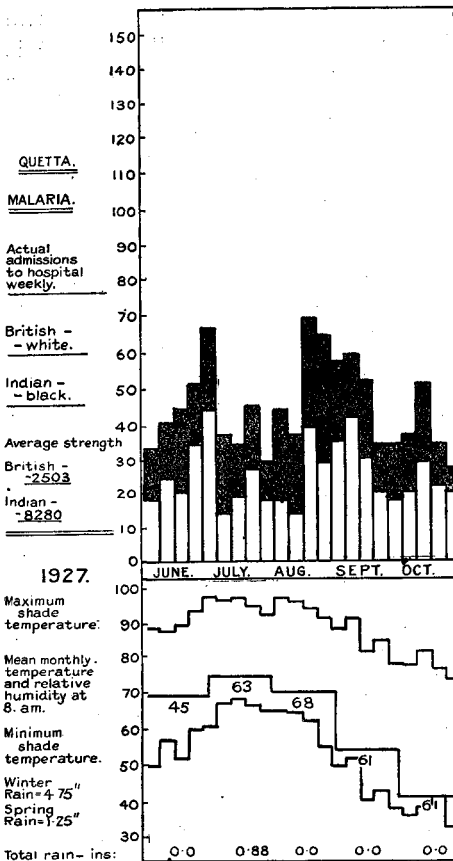


CHART II.

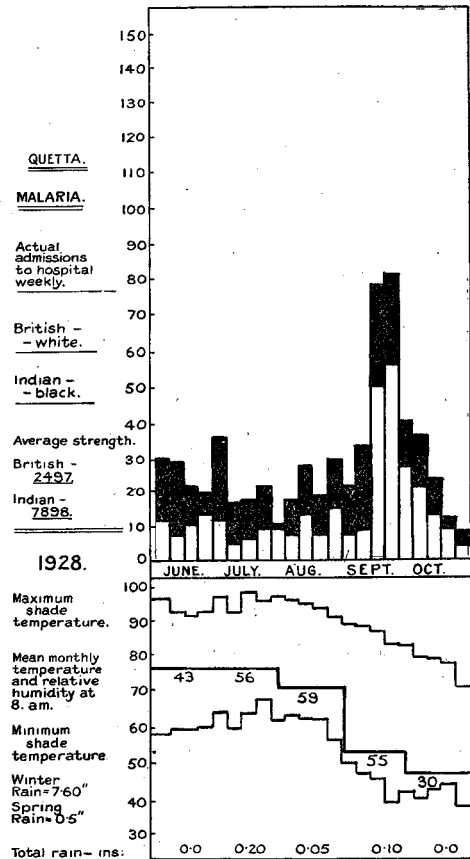


CHART III.

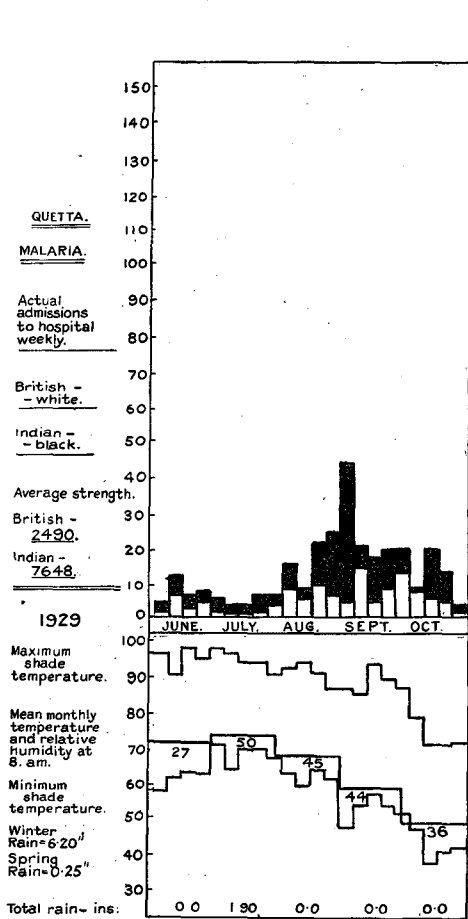


CHART IV.

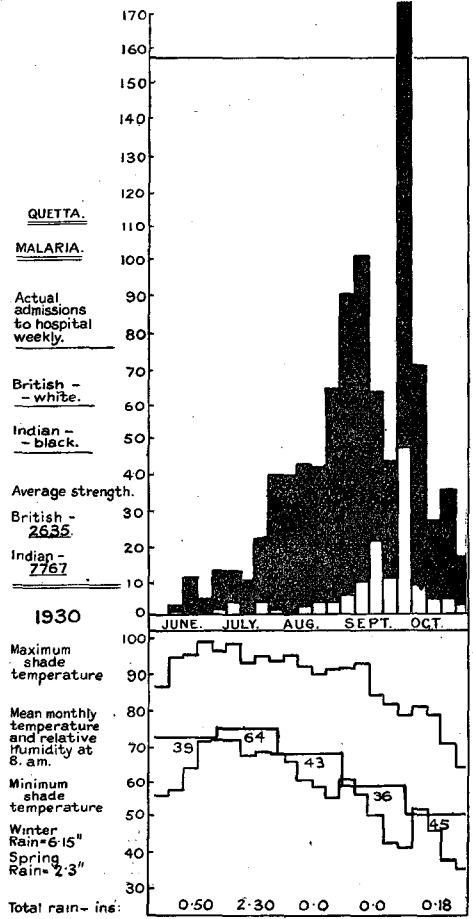


CHART V.

The following anophelines are recorded to have been found in, and near, Quetta ; the malaria-carrying potentiality of each is shown :—

<i>A. culicifacies</i>	+	+	+
„ <i>jeyporensis</i>	?	?	?
„ <i>lindesaii</i>	?	?	?
„ <i>listonii</i>	+		
„ <i>multicolor</i>	?		
„ <i>pulcherrimus</i>	?	?	
„ <i>rhodesiensis</i>	?	?	
„ <i>stephensi</i>	+	+	+
„ <i>subpictus</i>	?	?	?
„ <i>superpictus</i>	+	+	+
„ <i>turkhudi</i>	?	?	?

In the Punjab and the North-west Frontier Province I have always had very serious doubts regarding the practical utility of the so-called

“species sanitation,” as I have found as many as four species, of reputedly widely different habits, breeding together in waters of qualities varying from every point of view, and I am certain that at the height of the breeding season at any rate, all waters must be suspect of harbouring all or some species. I have not sufficient experience of the matter to venture an opinion whether this holds good for Baluchistan. There is here an opportunity for useful research.

Does *A. stephensi* inhabit karezses; or is the running water therein unfavourable to this species?

Does, in fact, any species commonly breed in karezses, except near their outlets; or is the depth and coldness of these places inimical?

What is the temperature of karez water at, say, twenty to eighty feet under the ground surface at different times of the year?

What is the breeding value of the highly saline tributaries of the Pishin Lora as regards different species; and, if they breed freely therein, how is their infectivity affected?

How, if at all, does the spleen rate in villages near these saline waters differ from that of villages in other parts of the district similarly related to water of other qualities?

What is the effect of such a dry climate on the parasite-carrying power of the species?

The questions which can be asked, to which there are, at present, no sound answers, are innumerable; and in suggesting them, I am well aware of the attacks against which I am defenceless; but the answers to most, if not all, of them, have a definite value in the prevention of malaria on this plateau. I can only plead that the experience of a single season, without any previous knowledge of the somewhat peculiar local conditions, and without previously existing organization for dealing with such special problems, is insufficient to base any useful replies to these particular questions.

Taking such facts as are known:—

Malaria is endemic on the plateau, and it may, in seasons favourable to it, appear with epidemic vigour.

In the city and cantonment of Quetta itself, mosquito breeding—to any dangerous extent—is not normally common on account of the interrupted nature of the irrigation water supply, the low relative humidity, the porous nature of the soil and the sparse vegetation, whereby residual pools rapidly dry up; with the proviso, of course, that some anti-larval measures are in force.

In the surrounding country, wherever there is a constant water flow, with consequent marginal vegetation, mosquito breeding between—roughly—mid-May and mid-September occurs freely, in some places intensely. The places where a constant water flow is most commonly found are the neighbourhood of villages and orchards. During the warmer months malarial infection may easily be contracted on one evening visit

to such spots, as not a few moonlight picnickers in the Hanna valley know to their cost.

Turning now to the charts, and considering first the actual incidence of malaria shown thereon.

The high early incidence in 1927 may reasonably be assumed to be the aftermath of an epidemic in 1926. That epidemic was associated—at least—with extensive manoeuvres undertaken relatively early in the season (August-September), and in a season of unduly high relative humidity and night temperature.

The marked rise recorded amongst British troops in September, 1928, was associated with a camp sited in close proximity to a large village. A similar camp was held at the same time of the year in 1929, but on a site removed some two miles, or more, from the village. Other factors, no doubt, played their part, but I personally (though I was not there) hold the first site, in this particular instance, to have been the main one.

On 1929 there is, at the moment, no comment to be made.

In 1930 the rise of incidence amongst Indian troops in August was associated with the necessity for the establishment of a camp in the Hanna valley to repair damage done to the water supply mains and to the road by a spate in July of uncommon volume. Following this is seen one of the results of the floods in Sind which were caused by the bursting of one of the banks of the Indus. Sappers and Miners were sent from Quetta to Shikapur to assist in the repair of the single railway line which connects Quetta with India. Had facts been known at the time which came to light later regarding the local distribution of malaria-carrying mosquitoes, and had the instructions which were issued for the immediate early treatment with quinine of these men on their return to Quetta after a fortnight's duty at the flooded area not miscarried, this rather severe outbreak should not have occurred. The sudden rise among British troops at the beginning of October was the result of certain leaks in the neighbourhood of a water reservoir situated in close proximity to the barracks of a British battalion. These leaks resulted from action taken by the military Engineer Services to try to clear up an unsatisfactory bacteriological condition of the drinking water supplied from, or through, that reservoir, which had persisted, in spite of other measures, since the July spate. Though these collections of water were noted, they did not, for one reason or another, receive any active anti-larval treatment—it was said that no larvæ could be found—yet a spot map of cases was sufficiently certain indication of the source of infection, and the simultaneous treatment of these pools and the removal of the battalion to training camp put, as the chart shows, a rapid end to the infections. The rise shown at the same time amongst Indian troops was more prolonged and was definitely confined to two battalions which had, during the first three weeks of September, occupied camp sites some fifteen miles out of Quetta in close relation to a large village. Two other Indian battalions and one British

battalion were in camp in the same area at the same time, but were located one and a half miles and upwards away from the village ; these units did not produce any instances of malarial infection.

Turning now to the meteorological data.

The quantity of winter rain and snow (November to March), and therefore, to a large extent, the quantity of local irrigation water available throughout the summer, does not appear, in these few years, to have been a factor of any real importance. Nor can it really be held, taking the other factors already noted into account, that the spring rains (April and May) had any marked influence in the matter ; though it is suggestive that in both 1927 and 1930 the incidence of malaria was considerable. The types of curve exhibited in the charts for these two years, however, are so grossly dissimilar that the possibility of such a common factor being decisively operative is not great.

From the year 1927 it would appear reasonable to suggest that a high relative humidity continuing above the normal is to be associated with a continuously high incidence of infection. This is in accordance with accepted theories and with facts relating to the bionomics of mosquitoes. But there have to be considered with this broad general factor the detailed habits of these insects ; and it is here, apart from the obvious fact that larger quantities of water provide more extensive breeding grounds, that the rainfall enters into the problem. An excessive rainfall, such as occurred in July, 1930, results in comparatively excessive vegetation along water channels, in thicker and more extensive crops, and in a general increase of shelter for such insects as mosquitoes. Though, as in 1930, the recorded relative humidity in the succeeding months may be even lower than the average, yet in and near excessive vegetation along running water courses, the local relative humidity remains sufficiently high to make such shelter a safe resting place for mosquitoes by day ; by night, as the air temperature falls, the drying power of the air decreases and does not endanger the life of the mosquito or of its contained parasites. This factor, though I have not yet found it stressed in print, is, I am convinced, one of the utmost importance ; it is a most powerful reason for the clearing of undergrowth from the immediate neighbourhood of all water.

At no time in the years under consideration does the maximum shade temperature rise to a point at which it might, of itself, be inimical to mosquito life. Nor in the few curves recorded does there appear to be any feature, or combination of features, which bear a constant relation, or, indeed, a casual one, to the histograms above them—save, of course, the decline at the end of the period. This decline, however, is more suitably, and probably more truly, related, by general consent, to the curve of minimum temperatures.

The year 1927 is complicated, as has been noted above, both by being the successor of an epidemic period and by the persistence of high relative humidities. It does, however, beginning in the third week of August,

suggest a factor now to be mentioned. The September rise in 1928 has already been adequately explained on the ground of locality; nevertheless it forms an exception of definite value as a criticism. Excluding the peak of incidence in Indian troops in August-September, 1930, which was derived from the Indus floods in Sind and not from Baluchistan, such rises as appear in the periods August, September, October—(1928 excepted)—can be definitely related to a minimum temperature increased above the normal during a period preceding their occurrence by some ten to twenty days (an average incubation period); in some instances—1927—the duration of this rise is prolonged; in others—1929, 1930—it lasts only for a week or less.

We may now, tentatively, generalize, recognizing that as records become more complete truer deductions may be made from them.

The months of June, probably, and July and August, certainly, are malarious on the Baluchistan plateau up to an altitude of at least 6,000 feet above sea-level; the lowest of the camps referred to in the Hanna valley in July, 1930, was at 6,200 feet. This district is especially malarious in areas uncontrolled by any anti-malarial activity.

The month of September may also be malarious—using the word to signify that the infection may then be contracted, though it may not become evident up to three weeks later—if the night temperature remains unduly high, even for a short period, and in direct proportion to this factor.

The persistence of a high relative humidity will probably mean a similarly increased liability to infections; but the occurrence of rain during the summer to such an extent as to produce lasting vegetation in excess of the normal will counteract a consistently low relative humidity, on account of local conditions immediately favourable to the continuance of mosquito life.

The neighbourhood of villages is particularly dangerous from the point of view of malaria infections, whether or no other factors are also assisting. This danger persists well into September in any case; though at that time an area equally irrigated and with equal vegetation less than a mile away will probably not be dangerous provided that the night temperature does not exceed the normal.
