

## Original Communications. ✓

NOTES ON THE METEOROLOGY OF  
CHOLERA IN MADRAS PRESIDENCY.

BY SURGEON-CAPTAIN H. HERBERT, F.R.C.S., I.M.S.

THE most important indices of the weather generally are the registers of the barometer and rain-gauge. They express the only features which I have found to bear very definite relationship to cholera activity in India.

*Rainfall.*—In this paper the northern strip of the presidency known as the 'Northern Circars' is excluded from consideration with the other districts, owing to peculiarities of cholera incidence and climate. And the rainfall alluded to here is still further restricted to the Carnatic only. This has been purely a matter of convenience in extracting figures from the Meteorological Reports. It, however, includes nearly all the important cholera districts. I have complete rainfall statistics from 1876; from 1871 to 1875 only the tables in Bellew's 'Nature, Causes and Treatment of Cholera.' Throughout this section of the paper each year must be understood to begin on March 1st and to include January and February of the following year. This is necessitated by the monthly distribution of cholera (see chart).

To begin with a medium type of year we must take 1883 and 1887, in which the cholera rate was low till the cold weather months, when it suddenly sprang up to a considerable height. The Carnatic rainfall of these years was about average from June to September ( $-0.92$  in. and  $-0.23$  in. respectively from normal), and excessive from October to December. In the years 1884, 1891 and 1875 there are progressive steps upwards of the summer cholera till in 1875 it almost equals the high winter cholera of that year. Correspondingly in these years there is a progressive diminution in the summer rainfall. The cool-weather rainfall, the north-east or 'retreating south-west' monsoon, was "remarkably copious" in 1884. In 1891 the excess was limited to the southern districts, and in 1875 there was drought in this season as well as earlier. In 1876 the drought in the summer was still greater, and the later monsoon was a failure except on the southern coast. The unparalleled cold-weather cholera of 1876-77 was largely due to the direct effect on the people of famine. The drought continued in 1877 till late in the south-west monsoon period. "A copious supply of rain fell in September and October . . . . The general effect was simply marvellous; cholera suddenly abated." This late rain merged into a very plentiful north-east monsoon. Thus the medium cholera year with average south-west monsoon and excessive north-east monsoon gradually rises into the severer year characterised

by drought not only in the summer but also to some extent in the cool season.

But there is a gradual change in another direction from the medium year, the cold-weather cholera elevation lessening, and the rainfall conditions gradually undergoing reverse. In 1888 the June to September rainfall variation was— $1.12$  in., October to December  $+ 2.58$  in. In 1881 June to September  $+ 2$  in. Accordingly, cholera did not start till after a very dry October ( $-3.44$  in.). The rain was excessive in November. December was dry except in the central and southern districts. In 1890 there is scarcely any cold-weather cholera rise. The south-west monsoon was a little above the average, and the 'retreating south-west monsoon' a little below the average. The year 1889 is noticed later. A further drop brings us to years like 1871 and 1872 with little, and 1872, 1873, 1874, 1879, 1880 and 1886 with practically no cholera. These are all except 1880 years of south-west monsoon above the average. Most of them 1873, 1874, 1879, 1882, 1886 have sub-normal (1886 especially light in southern districts), the others 1871 and 1872 excessive north-east monsoon rainfall. 1880 is noticed later. There remain only the years 1877 (already noticed), 1878, 1885 and 1892, marking the decline and fall of epidemic periods. These, too, are all years of heavy rain in the south-west monsoon. The north-east monsoon was above normal in 1877 and 1885; below it in 1878. In 1892 "moderate to heavy" in northern and central districts, drought in the southern districts.

It thus seems nearly invariable that—

- (1) The severest cholera years (March 1st to February 28th) are marked by drought, especially in the summer monsoon.
- (2) With cholera severe only in the cold weather there is an average south-west and an excessive north-east monsoon.
- (3) Cholera-free and falling-cholera years have more rain than usual in the summer, and commonly though not always a light cool-weather rainfall.
- (4) In cholera years generally there is a tendency to a strong north-east monsoon at least on the southern coast (1876, November 1881, 1891). And in cholera-free and falling-cholera years the tendency to light north-east rains is especially marked in the southern districts (November 1882, 1886, 1892).

To put it briefly, drought in the earlier monsoon is favourable and excess unfavourable to cholera prevalence. The influence of the retreating south-west monsoon appears quite subordinate to that of the other, and attains prominence only in the medium type of cholera year.

The relation borne by rainfall to cholera is not simple. It is curious that in the south-west monsoon, a time of light rain in the Carnatic, excess should be fatal. While later on in Octo-

ber and November, when the heaviest rain of the year falls, excess is favourable, provided the earlier rain has been light. But the cold-weather cholera does not usually attain any intensity till the heavy rain is over. When the cholera maximum occurs in December (as in 1875 and 1891) the late rains have been less than normal. It is noteworthy that cholera does not make a fresh start after complete absence until some rain falls. In 1881, when the summer rain was too heavy, the start was delayed till after a dry October. It seems that the cholera manufactory is at work chiefly in periods of light summer rainfall, but the full result is not seen until the ground is drying after the heavy north-east rains.

*Atmospheric Pressure.*—The Madras Presidency presents a somewhat imperfect example of the connection between high-pressure and cholera found in Bombay. Not only is the general relation less perfect, but the hot weather pressure variation loses much of its significance. This must be so where the chief cholera time is the cold weather, about as far removed from the influence of the preceding hot season as possible. Some notice, however, is due here of the 'relative local pressure anomalies' of Southern India compared with Northern India. The more remarkable examples occur in the hot weather. The medium years 1883 and 1887 (and less markedly 1884 and 1888) present definite instances of a positive Southern local anomaly in the month of May. The only other large positive local hot-weather anomaly was in 1892. The effect of this positive local anomaly in tending to divert the onset of the south-west monsoon is obvious.

The question of how far the pressure anomaly acts on cholera through its effect on rainfall distribution is a doubtful one. Rainfall variations have a much closer connection with cholera intensity in Madras than have those of pressure. There were only two definite exceptions to the general rule in the above series of years of rainfall. In 1880 the rainfall and pressure influences definitely clash. The absence of cholera accords with the long low-pressure period from the summer of 1878 to the summer of 1880, in spite of the favourable rainfall, deficient south-west and very abundant north-east rains. The year 1889 was practically a repetition of 1878 both as regards pressure and rainfall; but cholera did not drop in the cold weather as it did in 1878. Had it done so it would possibly have remained absent in 1890 as in 1880. Again, the remarkable cholera of 1875, 1876 and 1877 has so far been imperfectly accounted for.

*Sunspot Influence.*—It is possible these cholera excesses represent the result of a tendency to high atmospheric temperature at and shortly before years of sunspot minimum, the last three of which have been 1867, 1878 and 1891. "The mean (temperature) variation for the year (1889)

was . . . . larger than in any year since the year 1875." There is a decided tendency to the recurrence of periods of high atmospheric pressure, and particularly in Peninsular India of droughts and famines at and just before years of sunspot minimum. The cholera rates of the Bombay and Madras Presidencies (also the pressure variations as far as they are available) shew a double rise in each eleven-year sunspot cycle. The higher wave of the two has its chief elevation at or shortly before the sunspot minimum, especially in Madras, owing to the connection between drought and cholera prevalence there. This has been so regular as to maintain for some time a six-year cholera cycle in both provinces. The years of least cholera between successive periods of prevalence have been 1868, 1874, 1880 and 1886. The failure of its recurrence in 1892 is interesting as probably connected with the delay of two years in the appearance of the last sunspot minimum (1891 instead of 1889).

#### GANJAM AND THE CIRCARS.

Of this northern projecting strip of coast line, there is not much to be said. Taken as a whole it gives poor results. The four districts of which it is made up are discordant elements. In Ganjam the highest cholera rates generally come in the month of May, and only when the atmospheric pressure is distinctly high. Vizagapatam also shews evidence of the favouring influence of high-pressure on cholera development. In Godavery the chief cholera comes a little later in the year. It appears to flourish when the rainfall is heavy. This district is remarkable in being the only one where I have yet found a distinct connection between cholera intensity and humidity of the air. Unfortunately the register of the latter here only extends from 1884 to 1888. So far as it goes it displays a curious coincidence in the months of severest cholera and greatest humidity (absolute, not variation from average). The Ellore Circle at least of this district is remarkable for the nearness of the subsoil-water to the surface.

#### WELL-CONSTRUCTION AND THE PRESERVATION OF THE PURITY OF WELL WATER.

BY SURGN.-CAPT. P. HEHIR, M.D., F.R.S.E., D.P.H. CAMB.,  
Fellow, *Santy. Inst.*, Fellow of *British Inst.*, *Pub. Health,*  
*Health Officer, Chudderghat Municipality.*

THERE are three varieties of wells, shallow or superficial, deep and artesian. The last mentioned may be considered a variety of deep well, and we will dispose of it with a few words, for the reason that artesian wells have, up to date, served no practical purpose in Indian town or village hygiene.\* *Artesian wells* are made by

\* An artesian boring in Lucknow was given up after fruitlessly spending many thousands of rupees on it. Other attempts have likewise proved failures.