Letters To The Editor

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A POSSIBLE ROLE OF ATMOSPHERIC POLLUTION ON THE FREQUENCIES OF FOG AT ALIPORE, DUM DUM AND BARRACKPORE

1. Introduction

In a recent paper on the formation of fog at Alipore, Dum Dum and Barrackpore airports, Basu (1954) reached the following conclusions regarding frequencies of fog at these three observatories around Calcutta —

(1) The annual frequency of fog is higher at Dum Dum than either at Alipore and Barrackpore,

(2) During the coldest months, *i.e.*, December and January, Alipore has more cases of fog than either Dum Dum and Barrackpore,

(3) In February, the frequency of fog at Dum Dum increases more rapidly than at Barrackpore, while that at Alipore starts decreasing and

(4) In March, the frequency of fog falls rapidly at Alipore and Barrackpore but does so only gradually at Dum Dum.

He explained these observations from a study of the physical factors in the three different localities. In a big city like Calcutta, with a huge population and high concentration of industrial plants nearby, the concentration of atmospheric pollution in different localities must play an important role in determining frequencies of fog in each area. Basu (1954) only touched this point in explaining his second conclusion mentioned above. He did not, however, consider how far the phenomenon of atmospheric pollution may corroborate his other conclusions (obtained by statistical analysis of the observational data). In this note an attempt has been made to understand the contribution of atmospheric pollution in the formation of fog.

2. Geographical features

2.1. *Alipore*—Situated at a distance of 50 miles from the Bay of Bengal, the nature of the surface consists of hard grounds all round. To its north and east lies the city of Calcutta, while to the south the city limit terminates and to the west there are only dock yards. The density of population is high in this area, and it increases towards the north and decreases to the south. There is practically no industrial factory near the observatory.

2.2. *Dum Dum*—This airport is about sixtyfive miles from the Bay of Bengal and is on the northeastern side of Calcutta. To the south there are big areas of marshy lands and salt lakes.

The density of population here is much less, and it increases towards the west and southwest. To the west and southwest there are also a few factories, with a big railway and loco-yard towards the southwest.

2.3. *Barrackpore*—Barrackpore airport, which is about seventyfive miles from the sea, is at a distance of 15 miles north of the city limit. It is within half a mile from the river Hooghly and does not have any marshy land or hard ground. Vegetation increases as we go away from the city of Calcutta. In fact, the vegetation is quite thick near this airfield.

The density of population is small compared to Alipore and Dum Dum. There are many industrial factories to the north and to the south of this airfield along the river Hooghly.

The positions of the observatories are shown in Fig. 1.

3. General considerations of air pollution

In determining the role of atmospheric pollution on the frequency of fog at the

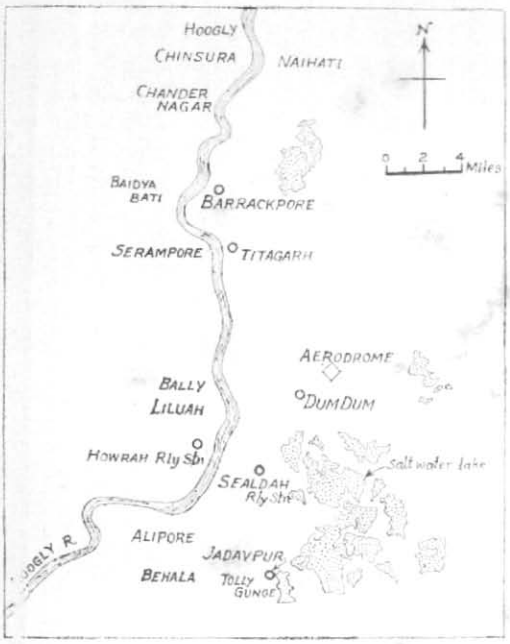

Fig. 1

above stations we should first of all know the ingredients of the pollution, but as yet there is no data available for the city of Calcutta.

The theoretical distribution of pollution from a group of point sources as represented by an industrial city has received little attention. An elaborate experimental study of atmospheric pollution in and near the industrial city of Leicester, England, has been made (Hewson 1952). The surface distribution of smoke as a function of wind speed shows that — (*i*) In calm wind the distribution of smoke round the centre of the city is symmetrical and decreases exponentially with distance, (*ii*) The downwind displacement of the centre of pollution is surprisingly small, never more than half a mile from the centre of the city, but contours of relatively lower percentages of smoke show some movement and (*iii*) Using ultraviolet light measured at various surface stations as an indicator of the total mass of smoke particles, the investigation revealed greater downwind displacement — a little more than a mile — of the centre of the whole body of smoke.

The above results indicate that the visible particles of smoke do not move much. The rate of settling of such particles, therefore, appeared to be greater than the rate of transport due to advection. The somewhat different result from measurements with ultra violet light shows that the smaller smoke particles are more liable to advection with the prevailing wind than their larger counterparts.

A more detailed study on the rate of settling of different particles in smoke was made by Rodebush (1952). As expected, it was found that the smaller the particle, the greater was its time of settling. There was yet another pollutant in smoke, chiefly from coal, that played an important role in forming fog, namely, gaseous sulphur dioxide. Being in the form of gaseous vapour it could move long distances from its source. Moreover, it was found (Hewson 1952) that under stable atmospheric conditions with low winds and slight turbulence, sulphur dioxide formed a stratified layer in the lower atmosphere.

Meteorologically, fog is declared when the visibility goes below 1 km and the relative humidity is above 75 per cent. In a congested city like Calcutta, domestic and industrial smoke and smoke from incomplete combustion of hydrocarbons present in automobile fuels cause considerable lowering of visibility. Even a slight increase in relative humidity may, therefore, cause the formation of fog.

4. Effect of air pollution

Atmospheric pollution in different localities depends on the concentration of pollutants and the prevailing meteorological conditions. While the wind is calm and air near the ground is stable due to the presence of an inversion or an isothermal layer, the pollution is due to local sources only. At Alipore domestic smoke in the evening considerably reduces visibility. During the coldest months of December and January, the evening wind is usually calm. The smoke, therefore, remains in the lowest layer of atmosphere throughout the night and a rise in humidity above 75 per cent causes fog. As Basu pointed out,

high incidence of fog at Alipore compared to Dum Dum and Barrackpore in December and January may be largely attributed to the local pollution of air. As both Dum Dum and Barrackpore are situated away from the city, local pollution there under the above meteorological conditions is less during these months.

In the month of February, the frequency of fog increases rather sharply at Dum Dum and gradually at Barrackpore, but decreases at Alipore. Basu (1954) attributes it to an increase in the southerly component of surface wind and subsequent transport of moist air at Dum Dum from a long stretch of marshy lands. But this factor alone, does not explain why the other observatories, which do not have such an extensive source of moisture, behave differently. Moreover, fog at Calcutta and neighbourhood is generally observed when southerly to southwesterly winds prevail in the lower layers of the atmosphere upto 1 km (Basu 1952). Thus, we see that when in February the southerly component of the air shows higher frequency than in January, the frequency of fog is naturally expected to increase. This is revealed by the observations at Dum Dum and Barrackpore; but contrary to expectations the frequency of fog shows a decrease at Alipore. The only possible explanation for this observation lies in the movement of polluted air. Frequency of southerly to southwesterly wind increases in February resulting in the removal of polluted air from Alipore and transport of the same to Dum Dum from the city and big railway yards, and to Barrackpore from the industrial area to the south. Thus, the frequency of fog increases at Barrackpore due to the increase in southerly component of wind which brings moisture and polluted air. At Dum Dum, the sharp increase in frequency is due to added transport of moisture from the local source of moisture to the south of the airfield. At Alipore, although the southerly component of wind increases the possibility of incursion of moisture, it decreases the amount of condensation nuclei in the air thereby causing a decrease in the frequency of fog.

The gradual decrease in frequency of fog at Dum Dum in March as compared to the rapid decrease at Barrackpore and a more rapid decresse at Alipore may be also explained in a similar manner. There is an increase in southwesterly component of surface wind in March, which maintains the transport of polluted air to Dum Dum airfield, while transport of such air to Barrackpore airfield either remains constant or decreases slightly.

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