Month	Hr. per day at each range of relative humidity		
	65–80 per cent	80–90 per cent	More than 90 per cent
January	9	4	11
February	8	5	11
March	8	5	11
April	7	5	12
May	9	6	9
June	9	13	2
July	9	9	4
August	10	11	3
September	9	9	6
October	10	7	7
November	9	6	9
December	9	5	10

From these figures it may be generalized that an 'average' day in Singapore has the following hours of humidity :

65–80 per cent relative humidity, 9 hr./day.
80–90 ,, ,, ,, ,, 7 ,,
More than 90 ,, ,, ,, ,, 8 ,,

These values bear a general resemblance to the average figures and ranges often quoted for Singapore : average maximum humidity, 95 per cent ; average minimum humidity, 69 per cent ; average humidity, 80 per cent. But these latter figures do not take into account the time of exposure to the maximum and minimum conditions. Time is just as important as the level of humidity in corrosion processes.

From the point of view of the deterioration of paint films on metal surfaces exposed to the direct rays of the sun, the sun temperature is of great importance, and work in Singapore has shown that sun temperatures of 130–150° F. are quite normal. A full investigation of these factors is being carried out and will be published elsewhere.

P. A. Cartwright
Operational Research Unit, Far East,
G.H.Q., FARELF. March 21.

[1] Vernon, *Trans. Farad. Soc.*, **23**, 162 (1927) ; **27**, 264 (1931) ; *Trans. Electrochem. Soc.*, **64**, 35 (1933). Hudson, *Trans. Farad. Soc.*, **25**, 205 (1929). Patterson and Hebbs, *Trans. Farad. Soc.*, **27**, 277 (1931). Patterson and Wilkinson, *J. Soc. Chem. Indust.*, **57**, 445 (1938) ; **60**, 42 (1941). Bengough and Whitby, *Trans. Inst. Chem. Eng.*, **11**, 176 (1935).
[2] Clarke, *J. Electrodep. Soc.*, **15**, 158 (1939).
[3] John, Malayan Meteor. Service, Summary of Observations 1953 (Gov. Printing Office, Singapore).

I should like to make two comments on Major P. A. Cartwright's letter printed above.

(1) Major Cartwright is right in stressing the important bearing of climatic conditions on atmospheric corrosion, and his view that the variation in the relative atmospheric humidity throughout the exposure period is much more important than the overall average value will meet with general approval. I am particularly interested in this aspect of the matter and have from time to time published diagrams such as Fig. 1, one of which relates to Singapore.

According to the classical researches of Vernon, the critical humidity for the atmospheric rusting of iron lies somewhere between 70 and 80 per cent relative humidity. In the diagrams I have, therefore, shown the periods of the day, averaged for each month of the year, during which the relative humidity of the atmosphere at the places concerned lies below, between, or above, these limits. We do not know whether or not the critical relative humidity varies with the atmospheric temperature ; but, if we assume a value of 70 per cent everywhere, the diagrams show that the conditions are propitious for rusting at Singapore during no less than 99 per cent of the year ; the corresponding figures for Kew and Pittsburgh are 80 and 49 per cent, respectively. Incidentally, the Pittsburgh figure and corresponding data for other American observatories suggest that on the whole the corrosion hazard due to humidity alone is rather less in the United States than in Great Britain.

(2) It does not follow that serious corrosion will take place whenever the humidity is favourable. As Vernon showed, it is also necessary that the atmosphere should be polluted. The most damaging type of pollution is sulphur in the form of combustion products. Joint investigations by the British Iron and Steel Research Association and the Fuel Research Station have shown that in Great Britain, where the relative humidity does not vary much over the whole country, the corrosion of iron at different sites is directly proportional to the sulphur pollution of the atmosphere. Where the sulphur pollution is inappreciable, the rate of rusting is small. In conformity with this, in earlier tests made at Singapore itself, on mild steel plates freely exposed in the open at Seletar Aerodrome, the average rate of rusting observed was only 0·6 mil (0·0006 in.) per year. This figure is comparable with the rates for rural atmospheres in Great Britain—for example, 1·2 mils per year at Llanwrtyd Wells—and is much smaller than those observed in industrial atmospheres, such as Sheffield, where figures of 4 mils or more per year are not uncommon.

This does not contradict the fact that very severe corrosion may often occur in the tropics. Humid atmospheres heavily charged with salt spray, such as are found on surf beaches, are extremely corrosive, and rates of 40–50 mils per year have been recorded at sites of this type. Although the corrosion-rate falls off rapidly with increasing distance from the sea, heavy condensation may play a decisive part at inland tropical sites, since it is clear that the ease with which condensed moisture evaporates from the metal is very important. It is difficult to reproduce the full effects of this factor in small-scale experiments, and it may well be that, for practical purposes, observations made on actual articles and components will provide a better guide to the severity of the corrosive attack that is to be expected in jungles and similar places.

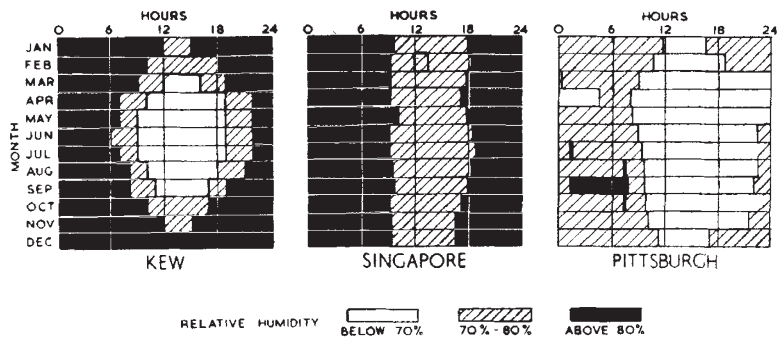

Fig. 1. Variation in the relative humidity at Kew, Singapore and Pittsburgh throughout the day

J. C. Hudson
British Iron and Steel Research Association,
140 Battersea Park Road,
London, S.W.11. Sept. 14.