

were as nearly as possible the same, except that on some days the mechanical ventilation was in operation, and on other days not, open windows, &c., being used instead. We found, to our surprise, that whereas the carbonic acid present in the air was increased from 12.6 to 18.6 volumes with the mechanical ventilation not in operation, the average number of micro-organisms remained almost exactly the same. Even when the mechanical ventilation was kept off for a week this had no distinct effect in increasing the number of micro-organisms. These anomalous results did not lead us to doubt the effects of mechanical ventilation in diminishing the number of micro-organisms in air, as we found the number very small even in rooms where every other condition except the ventilation seemed to favor a large number. We were, therefore, forced to conclude that while the ventilation at the time is the decisive factor in influencing the amount of the gaseous impurities, it is, other things being equal, the habitual state of the ventilation which influences the micro-organisms. This led us to inquire into a number of points regarding the sources of the micro-organisms.

It had previously been proved by Tyndall and others, that physical disturbances of any kind, such as those caused by the presence of human beings, have a great effect in disseminating micro-organisms in air, and that air left perfectly still gradually deposits its micro-organisms. We naturally, at first, expected that varying amounts of physical disturbance would very much obscure other differences. It turned out, however, that this is not the case. Although the influence of difference in physical disturbance is well marked, under ordinary circumstances other influences have a much greater effect, as we shall see.

That the micro-organisms do not come from the breath, but are on the contrary filtered off by respiration, we showed by means of some experiments, the details of which need not be described here (see "Phil. Trans.," vol. 178, B, page 92.) That they do not come in any large number directly from the clothes or skin of the persons present in a room was shown by a number of observations made in the two chemical lecture rooms. Even during a course of crowded popular lectures there was found to be an average of only four micro-organisms per litre, as compared with an average of about three when the room had remained empty. Nor did the number

rise beyond six per litre when the room was left unventilated during the lecture, and the carbonic acid rose to nearly 40 volumes per 10,000. This conversation alone shows strikingly, I think, that the carbonic acid is no measure of the number of micro-organisms in the air of a room.

The micro-organisms thus do not come to any large extent from the bodies of the persons present at the time. Nor do they come from the outside air, which is comparatively free from micro-organisms during winter, as shown both by our own experiments and by the more recent and systematic ones of Dr. Percy Frankland. We must therefore conclude that they come from the floor and other parts of the room itself. If this is really so, the state of a room as regards cleanliness ought to have an effect on the number of micro-organisms. This was found to be actually the case, as shown in the following classification of both schools and houses:—

		No. of cases	Average space per person	Average carbonic acid	Average organic matter	Average micro-organisms
One-roomed house...	(Clean .....	1	295	8.0	13.1	18
	Dirty .....	7	200	9.9	18.1	41
	Dirty .....	13	221	10.7	13.5	49
	(Very dirty ..	6	220	11.0	15.1	93
Two-roomed houses.	(Very clean ..	2	273	12.5	10.8	10
	Clean .....	4	231	9.3	7.7	22
	(Dirty .....	7	233	9.4	11.2	69
Naturally ventilated Board Schools	(Cleaner .....	12	167	19.7	18.1	91
	Average cleanliness ..	12	166	14.2	16.2	125
	(Dirtier .....	12	191	22.5	15.2	198
Mechanically ventilated schools and college	(Cleanest .....	7	191	12.5	12.7	3
	Clean .....	11	155	12.8	8.3	10
	(Less clean ..	4	152	10.8	9.8	30

We next classified the schools according to age and obtained the following results:—

	No. of cases	Micro-organisms per litre
Opened before 1866 .....	7	211
" 1875-1880 .....	20	150
" 1881-1885 .....	5	38

This was not at all what we expected to find. One would rather have anticipated that the micro-organisms, like the ordinary dust particles in a room, would very soon reach a maximum, depending on how often the room was cleaned. But the causes under the action of which a room becomes infested with micro-organisms are evidently no merely temporary ones, but have a gradually cumu-