THE MICROORGANISMS IN THE AIR OF THE HOUSE OF COMMONS.

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CONTENTS.

The investigations described in the present paper were undertaken during the summer of 1902, at the request of the Select Committee on the Ventilation of the House of Commons.

Methods of collecting and cultivating the organisms in the air.

As a result of certain preliminary experiments, it was decided to adopt a slight modification of the method described by Frankland[4] in 1887. The principle of the method is to entangle the micro-organisms in plugs of tightly packed glass wool by drawing known volumes of air through them. An air pump of known capacity, or under certain conditions automatic aspirators, were used for the aspiration of the air through glass collecting tubes fitted with glass wool plugs.

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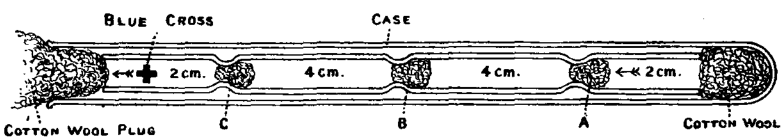
The collecting tubes.

The collecting tubes were made from strong glass tubing ·5 cm. in internal diameter and 12 cms. in length. Each was provided with three plugs of finely divided glass wool (*A*, *B*, *C*) kept in position by constrictions in the tubes. The constriction behind *C* was first made and the plug inserted, next that behind *B*, and finally the one behind *A*. The tube was then marked at the end nearest *C* with a blue cross, and was placed inside a stout glass test-tube, whose open end was plugged with cotton-wool, to act as a sterile case when the collecting tube was not actually being used. The blue-marked end of the collecting tube was placed nearest the open end of the test tube, so that when the latter was opened this end should first drop into the hand. In all subsequent proceedings this end was alone handled, and fixed to the tube of the air pump or aspirator, and at the end of the experiment the collecting tube was again placed inside its case in the same position.



Arrows mark direction of air current.

Before use the collecting tube in its case was sterilised at 160° C. in hot air on these occasions.

During the collection of the sample the air passes through the collecting tube from *A* to *C* and the majority of the organisms are entangled in the plug *A*. On a few occasions a small number passed through to plug *B*, which is used as a control to ascertain what proportions of organisms are carried through *A*.

Plug *C* is to prevent contamination of the other plugs when the collecting tube is being handled.

For the aspiration of the air through these collecting tubes an air-pump was used in the majority of examinations connected to the collecting tube by a rubber pipe about 10 feet in length, so that the disturbance caused by the working of the pump should not influence the air at the place where the samples were being collected.

For experiments in the chamber during a sitting such a method was found to be inconvenient. In this case a known volume of air was aspirated by connecting the collecting tube by means of a length of

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lead piping to a graduated carboy from which water was being siphoned into another vessel.

Cultivation of Samples.

After removing the collecting tube from its case, it was cut through half way between *A* and *B*. The free and cut ends were sterilised by passing quickly through a flame, and the plug *A* pushed by means of a sterile wire into a Petri dish containing melted sterile gelatin. The plugs were then broken up and evenly spread out with a sterile platinum needle. The samples were cultivated for 5 days or longer at 20° C. At the end of this time the colonies were counted under a lens, and subcultures made to determine the species of the organisms found.

In this way numerical estimations of the numbers of the organisms per litre were made of the outside air at various places, the Debating Chamber before, and during, debates, the ventilating shaft leading to it, and various Committee, Smoking, and Dining Rooms.

Results of Experiments.

TABLE I.

Experiments on outside air, July 18th. 4·5 litres of air aspirated in each case.

No. of exp.	Place	No. of bacterial colonies	No. of mould colonies	Total colonies	No. of organisms per litre
I	Terrace (ground level)	14	5	19	**4·2* (1·1)†**
II	„ (10 ft. from ground)	8	5	13	**2·9 (1·1)**
III	„ (20 ft. from ground)	6	9	15	**3·3 (2·0)**
IV	Clock Tower (half-way up)	6	1	7	**1·5 (0·2)**
V	„ „ (top)	3	3	6	**1·3 (0·6)**
VI	Peers' Inner Court	16	3	19	**4·2 (0·6)**
VII	Star Court	21	6	27	**6·0 (1·3)**

* indicates number per litre of bacteria and moulds in this and other tables.

† Moulds per litre in brackets ( ) in this and all other tables.

The figures just quoted show that very few bacteria were present in the air at the top of the clock tower (1·3)[1] and that the numbers were about the same half-way up (1·5). At 20 and 10 feet above the ground level there was however a considerable increase, 3·3 and 2·9 respectively, and at the ground level (Terrace) the number was still greater, 4·2.

[1] All figures, here and elsewhere in the text, record the number of micro-organisms per litre.

Two closed courts were also examined and showed in one case the same number as on the Terrace and in another an increase of 2 per litre (6·0).

At the time when these experiments were conducted there was a slight west wind and the day was bright and moderately sunny. No smoke zone was observed in ascending the clock tower and consequently no experiments were made to ascertain whether greater, or lesser, numbers of micro-organisms are present amongst these floating particles.

Comparison with the observations of other experimenters.

The observations of several investigators[1] have shown that the numbers of the micro-organisms in the outside air are dependent on various factors, such as the time of year, condition of the weather, time of day, and the locality, especially with regard to the height of the latter, and the free circulation of air about it.

Influence of the time of year.

The experiments of Frankland (5), Griffiths (8), and others show that the numbers are least during the winter months and greatest during the summer, reaching a maximum during August. Frankland records the following results from observations on the roof of the Science School, Kensington.

January	·4	August	10·5
March	2·6	September	4·3
May	3·1	October	3·5
June	5·4	November	1·3
July	6·3	December	2·0

Griffiths (8) found in two situations in Lincoln that the maximum was reached in August and that the mean number from November to March was about half that from April to October.

Lincoln.	Top of Hill.	November to March	Mean	·5
		April to October	,,	1·6
	Base of Hill.	November to March	,,	1·5
		April to October	,,	3·4

[1] Although much work has been done by Petri, Miquel and other continental bacteriologists on this subject, the observations here quoted are mostly those of English investigators, as being most suitable for comparison with the present experiments. The method adopted by each is given with the references to the literature at the end. No figures obtained by the simple exposure of plates have been quoted.

Miquel[9] found in the centre of Paris, in Winter 2·8, Spring 8·9, Summer 12·2, Autumn 6·8.

Influence of weather.

Carnelley, Haldane and Anderson[2] found the proportion of bacteria to moulds in the outside air considerably influenced by the condition of the weather:

On still, damp days this ratio was			1
On windy days,	,,	,,	1·3
On still, dry days	,,	,,	2·6
On windy, dry days	,,	,,	14·1.

They conclude that moulds are not so much affected as bacteria by changes in dampness.

Influence of altitude.

Numerous observations have established the fact that the numbers in the outside air rapidly decrease with the height of the place in which the observation is made.

The results of Griffiths'[8] experiments at Lincoln have just been quoted. They show that in winter there are three times as many bacteria at the bottom as at the top of the Hill, and in summer twice as many.

Frankland[6] has made several observations on this point. His figures are:—

Primrose Hill (top)		·9
(bottom)		2·4
Norwich Cathedral (top of spire, 300 ft.)		·7
(tower, 180 ft.)		·9
(close)		1·8
St Paul's Golden Gallery	1·1	1·0[1]
Stone ,,	3·4	3·7
Churchyard	7·0	4·6

Influence of locality.

It has been found, however, that the numbers present in a locality under observation are influenced to a still greater extent by its surrounding, than by any of the factors yet given, the numbers being greatest in crowded districts, and least in more open spaces.

As instances of this, Frankland gives the following figures[7].

Kensington Gardens	1·3	......[6]	2·1	and	·5
Hyde Park	1·8	......	4·8	,,	3·8
Exhibition Road	55·4	......			

On this point Griffiths[8] also made a series of experiments in London.

		July	August
Forest Hill	...	4·2	5·3
City (near Bank)	...	5·6	7·3
Piccadilly	...	5·3	6·4
Near Monument	...	5·8	7·0

In Dundee town, in quiet places, Carnelley, Haldane, and Anderson[2] found a mean of ·8, as against ·1 in the suburbs.

Influence of Day and Night.

The same observers arrived at the conclusion that open spaces give lower results during the night, and that even close places by night give a lower average than open spaces by day, the moulds particularly showing a large reduction.

	Day	Night	
	Open places	Open places	Close places
Dundee[2]	bacteria ·7, moulds ·5 } = 1·2	bacteria ·15, moulds ·0 } = ·15	bacteria ·49, moulds ·04 } = ·53.

They also made certain experiments illustrating the same point in the courts of the Houses of Parliament (p. 504).

Numbers found in the outside air during the present experiments.

The present experiments were made during the month of July, and from a consideration of the observations just quoted the figures might have been expected to be rather high. The weather was fine and sunny (19° C. in shade and 28° C. in sun).

Experiments I—V correspond closely to the results of Frankland[4 and 6] at St Paul's, showing a gradual increase from 1·3 at the top of the Clock Tower to 4·2 on the Terrace level. It has been shown that the numbers in open spaces are not great even in London, and the latter figure may probably be taken as a fair estimate of the numbers near the ground level in the open space about the Houses of Parliament.

Samples taken at 1 p.m. from two closed courts, the Peers' Inner

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Court (VI) and the Star Court (VII), give 4·2 and 6·0 respectively. Carnelley, Haldane and Anderson [2] made an examination of the central court of the Houses of Parliament in 1887, finding on

April 19th, 20th	8.30 p.m.	...	9·2
	1.0 a.m.	...	4·4
May 18th, 19th	6 p.m.	...	22·0
	12.30 a.m.	...	4·5

They state that during the earlier experiments the traffic in the streets was very great, and quote these results as showing the great diminution in the numbers of organisms found in the night as compared with the day. Experiments VI, VII give numbers only slightly higher than those above quoted in the night, but the places in which they were made would not be much influenced by traffic in the streets.

Experiments within the House.

The arrangements for the ventilation of the Debating Chamber have been fully described and figured in the preceding paper by Mr Butterfield. It will therefore be sufficient to remark here that the air passes upwards from the equalising chamber to the Debating Chamber through a perforated grating covered with string matting and extending over the whole of the free space on the floor, including the gangways. Part also enters by openings under the seats. The outlet is through openings in the roof.

As has previously been mentioned, automatic aspirators were made use of in the investigations in the Chamber during sittings. In each of the four series of observations made at 7 and 7.15 p.m., 10.30 and 10.45 p.m. respectively, five aspirators were simultaneously in use—four situated in the equalising chamber and one on the roof. One of the former was connected with a collecting tube placed in the equalising chamber under the central grid of the floor of the House, and three by means of long lead tubes passing through the floor of the Debating Chamber with collecting tubes fixed to the backs of the Members' seats. One of these collecting tubes was placed on the third seat on the Government side at the breathing level, and one in a similar situation on the Opposition side. A third was fixed at a high level behind the Government seats. A collecting tube connected with a similar aspirator was projected through an opening in the roof over the entrance door.

In taking these samples the collecting tubes were attached to their pipes at a definite time by certain Members, and the aspirators in the equalising chamber then turned on. After five minutes the aspirators were stopped, the tubes removed, and the volumes of air drawn through the collecting tubes read off.

In the other mechanically ventilated rooms the air is extracted by propeller fans placed in the windows. The inlets are through flues connected with gratings on the walls.

TABLE II.

Experiments in Ventilating Shaft of chamber, etc., July 18th.
4·5 litres of air aspirated in each case.

No. of exp.	Place	No. of bacterial colonies	No. of mould colonies	Total colonies	No. of organisms per litre
VIII	Air inlet at Terrace	4	1	5	**1·1 (0·2)**
IX	End of first passage	4	0	4	**0·8**
X	In front of scrim cloth	9	0	9	**2·0**
XI	Behind scrim cloth	6	1	7	**1·5 (0·2)**
XII	Inside cotton wool filter (working)	3	1	4	**0·8 (0·2)**
XIII	Equalising chamber	4	0	4	**0·8**
XIV	Debating Chamber over central grid	6	6	12	**2·6 (1·3)**

The results of the examination of the air at various points in the ventilating passages to the Chamber itself are given in the above table and show that but few organisms were present in the entering air, at any rate on the day of the examination. When no debate was in progress very few bacteria were present in the equalising chamber below the central grid (·8), and on the floor level of the chamber itself over the central grid only 2·6 were found under these conditions.

During debates the mean of four experiments in the equalising chamber (XXI, XXII, XXXI and XXXII) shows that there was a considerable increase (8·3) over the number found in the incoming air when no debate was in progress (·8). The position selected below the central grid is, however, the one in the equalising chamber most likely to be contaminated by the dust falling through from the Chamber above. Though the increase is considerable, yet even during debates, the number is low for such a position, and about the same as the average found by Frankland in the outside air of London in summer.

Four sets of experiments were conducted within the Chamber itself during debates, two at 7 p.m. when the House had been sitting 5 hours, and two at 10.30 p.m. when the sitting had lasted 8½ hours (including the dinner interval). The results of these experiments are given in Tables III and IV.

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TABLE III.

Experiments in the Chamber during a debate, July 21st, 7—7.15 p.m.
Temperature 18° C.

No. of exp.	Place	No. of bacterial colonies	No. of mould colonies	Total colonies	Litres of air aspirated	No. of organisms per litre
XV	Government side, third seat	34	14	48	4·5	**10·6 (3·1)**
XVI	,, ,, ,,	18	3	21	4·0	**5·2 (0·7)**
XVII	Government side, back seat	26	5	31	6·0	**5·1 (0·8)**
XVIII	,, ,, ,,	17	7	24	5·5	**4·4 (1·2)**
XIX	*Opposition side, third seat	—	—	—	—	—
XX	,, ,, ,,	18	10	28	4·5	**6·2 (2·2)**
XXI	Equalising chamber, under central grid	25	15	40	5·0	**8·0 (3·0)**
XXII	,, ,, ,,	27	10	37	4·0	**9·2 (2·5)**
XXIII	Roof over entrance door	30	14	44	5·0	**8·8 (2·8)**
XXIV	,, ,, ,,	26	15	41	5·0	**8·2 (3·0)**

* Aspirator failed to work.

XV, XVII, XIX, XXI, XXIII, were carried out simultaneously at 7 p.m. and XVI, XVIII, XX, XXII, XXIV simultaneously at 7.15 p.m. The day was windy and damp. 282 persons were present, namely 176 Members, 66 strangers, 28 reporters, and 12 ladies. A division took place at 6.30, 393 Members being present.

TABLE IV.

Experiments in the Chamber during a debate, July 21st. 10.30—10.45 *p.m.*

No. of exp.	Place	No. of bacterial colonies	No. of mould colonies	Total colonies	Litres of air aspirated	No. of organisms per litre
XXV	Government side, third seat	17	11	28	4·0	**7 (2·7)**
XXVI	,, ,, ,,	14	10	24	4·0	**6 (2·4)**
XXVII	Government side, back seat	15	7	22	5·0	**4·4 (1·4)**
XXVIII	,, ,, ,,	11	2	13	2·5	**5·2 (0·8)**
XXIX	Opposition side, third seat	23	6	29	5·5	**5·2 (1·0)**
XXX	,, ,, ,,	13	10	26	4·5	**5·7 (2·2)**
XXXI	Equalising chamber under central grid	26	12	38	4·5	**8·4 (2·6)**
XXXII	,, ,, ,,	22	13	35	4·5	**7·7 (2·8)**
XXXIII	Roof over entrance door	30	5	35	5·0	**7·0 (1·0)**
XXXIV	,, ,, ,,	26	6	32	5·0	**6·4 (1·2)**

XXV, XXVII, XXIX, XXXI, XXXIII were carried out simultaneously at 10.30 p.m. and XXVI, XXVIII, XXX, XXXII, XXXIV at 10.45. 305 persons were present, namely 152 Members, 108 strangers, 26 reporters, and 19 ladies.

They indicate that the organisms are most numerous in the equalising chamber. The numbers near the roof are nearly as great. Within the Chamber itself, the greatest number was found, as would be ex-

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pected, on the most crowded side, namely the Government third seat (7·2), next most numerous on the Opposition third seat (5·4), and least at a high level behind the Government benches (4·8).

By taking the highest numbers obtained, namely those in the equalising chamber, as 100 % the following ratio is obtained, 91 % at the roof, 87 % third Government seat, 65 % third Opposition seat, and 57 % above Government back seat.

Although the actual numbers were excessive, the ratio obtained from the earlier experiments is, with the exception of the third Government seat, almost identical, namely equalising chamber 100 %, roof 96 %, Government third seat 123 %, Opposition third seat 57 %, and above Government back seat 53 %.

The results of the experiments within the Chamber are given shortly in the annexed table.

TABLE V.

Summary of experiments in Chamber during debates, July 21st.

Position of Tube	Organisms per litre				Mean of all experiments	Ratio
	Early Series		Late Series			
	7 p.m.	7.15 p.m.	10.30 p.m.	10.45 p.m.		
Government side, third seat	10·6 (3·1)	5·2 (0·7)	7·0 (2·7)	6·0 (2·4)	**7·2** (2·2)	87 %
Government side, above back seat	5·1 (0·8)	4·4 (1·2)	4·4 (1·4)	5·2 (0·8)	**4·8** (1·0)	57 ,,
Opposition side, third seat	—	6·2 (2·2)	5·2 (1·0)	5·7 (2·2)	**5·4** (1·8)	65 ,,
Equalising chamber	8·0 (3·0)	9·2 (2·5)	8·4 (2·6)	7·7 (2·8)	**8·3** (2·7)	100 ,,
Roof	8·8 (2·8)	8·2 (3·0)	7·0 (1·0)	6·4 (1·2)	**7·6** (2·0)	91 ,,

It is interesting also to observe that the numbers were in most cases remarkably uniform, and that there was no increase at the later time. During the experiments at 6.30, 282 persons were present in the Chamber and Galleries, and at 10.30, 305 persons.

When the experiment in Committee Room No. 9 was made the fans were working, and 150 persons were present. The result showed 20·9 organisms per litre. In Committee Room No. 1 with only 41 persons present, the windows open but no fans working, the mean of two experiments (XXXVII, XXXVIII) gave 34·6.

In these rooms therefore three and five times as many bacteria were discovered respectively as in the Chamber itself.

TABLE VI.

Experiments in Committee, Dining, and Smoking Rooms.
4·5 litres of air aspirated in each case.

No. of exp.	Place	No. of bacterial colonies	No. of mould colonies	Total colonies	No. of organisms per litre
XXXV*	Committee Room No. 9. Fans working, 150 persons present. 1.45 p.m.	42	18	60	**13·3** (4·0)
XXXVI	,, ,, ,,	73	21	94	**20·9** (4·6)
XXXVII	Committee Room No. 1. Fans not working, windows open, 41 persons present. 1.30 p.m.	136	24	160	**35·5** (5·3)
XXXVIII	,, ,, ,,	133	19	152	**33·7** (4·2)
XXXIX	Central Dining Room. 36 persons present. 8 p.m.	153	33	186	**41·3** (8·4)
XL	,, ,, ,,	145	54	199	**44·2** (12·0)
XLI	Members' Smoking Room. 24 persons present. 9 p.m.	90	48	138	**30·6** (10·6)
XLII*	,, ,, ,,	19	20	39	**8·6** (4·4)

* In each of these cases part of the plug was loosened during transit and the result is therefore not reliable.

Samples from the Members' Smoking Rooms showed 30·6 per litre (XLI), being about the same number as found in Committee Room No. 1, but from the Central Dining Room still higher figures were obtained, namely, 41·3 and 44·2, mean 43·2.

In certain samples of dust enormous numbers of micro-organisms were present. These samples were obtained from the Ways and Means Corridor, the Chamber itself, and the corridor outside the Lavatory.

That from the Ways and Means Corridor gave in ·01 grammes 18,944 colonies or about 1,900,000 per gramme.

Comparison of the above figures with the results of other investigations on air within rooms.

It is probably most advantageous to compare the numbers of organisms found in the Debating Chamber, Committee, and other rooms with those found in schools.

It has already been shown (p. 502) that to some extent the numbers, and proportion of bacteria to moulds, depend in such situations on conditions of the weather. There are, however, other factors which influence the numbers in a much greater degree, namely the locality, cleanliness, age, and ventilation of the building, and the amount of disturbance of the atmosphere.

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Influence of Locality.

Carnelley[1] has demonstrated that even within buildings the altitude exerts some influence. He found on the average the following numbers in schools situated at various altitudes.

Situation	No. of schools examined	Organisms per litre
High	25	95
Medium	20	106
Low	19	164

Even the slight difference caused by the flat on which the room is situated causes an appreciable difference according to this observer.

Situation	No. of schools examined	Organisms per litre
Downstairs	28	122
Upstairs	28	62

The same investigator also gives figures to illustrate the influence of open, and closed, situations.

Situation	No. of schools examined	Organisms per litre
Most open	18	66
Medium	18	84
Least open	17	135

(These figures have been inserted to show that some differences have been found to prevail under the conditions mentioned. It is evident, however, that the more highly, and more openly situated, schools are probably the more recent, and cleaner. Upper and lower rooms also may not be occupied to the same extent. In consequence of these considerations too much stress should not be laid on these results.)

Influence of the Age of the Building.

It has been shown by Carnelley[1] and by Carnelley, Haldane, and Anderson[2] that the age of the building has a most striking influence on the numbers found in the school rooms.

		Years opened	No. of cases	Organisms
(1)	Country Schools ...	more than 22 years ...	24 ...	81
		between 17—13 ,, ...	16 ...	65
		within 1 year ...	3 ...	36
	Schools in suburbs and county towns	more than 22 years ...	4 ...	199
		between 15—9 ,, ...	41 ...	97
		within 1 year ...	6 ...	65
(2)	Schools in Dundee	Built before 1866	7 ...	311
		,, between 1875—1880	20 ...	150
		,, ,, 1880—1885	5 ...	38

(Experiments made in 1886.)

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Influence of Cleanliness.

The two sets of observers from whom the last figures were quoted have also demonstrated that the cleanliness, or otherwise, of the rooms of schools and dwelling houses is a factor of some importance in determining the numbers present.

Schools	Natural ventilation	Mechanical ventilation
Cleaner	91	3
Average	125	16
Dirtier	198	30

Influence of Ventilation.

Of all the various factors which have a bearing on the number of micro-organisms present in the air of rooms, probably ventilation is the most important. It has been found, however, that mechanical ventilation at the time of the experiment is of little importance, but the following tables from Carnelley [1] show that the effect of habitual mechanical ventilation is well marked.

			No. of schools examined	Organisms
Town schools (Aberdeen).	Natural ventilation	...	17	136
,, ,, (Dundee).	,, ,,	...	19	152
,, ,, (Aberdeen).	Mechanical ,,	...	3	20
,, ,, (Dundee).	,, ,,	...	4	17

The immense difference made by efficient mechanical ventilation is also well brought out by the observations of Carnelley, Haldane and Anderson [2]. They found in schools with

Natural ventilation ...	28 cases ...	152·1 organisms
Mechanical ,, ...	18 ,, ...	16·58 ,,

Sources of the micro-organisms found in the Air.

The latter observers [2] have made it clear that bacteria are not given off in the ordinary respiration of healthy persons, and that the number of micro-organisms given off by the skin and clothes of persons actually present in a room is small compared with those coming from the dust in the room. They have also shown that in dwelling rooms the micro-organisms decrease as the cubic space increases. They quote the results of Hesse who has proved that when a room is left quiet the micro-organisms settle out in a few hours so that the air becomes comparatively free.

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Certain observations made by them demonstrate the fact that the disturbance of dust as by stamping of feet causes an enormous increase of organisms, in one case from 11 to 150. The making of the beds in an Infirmary resulted in an increase from 2·8 to 28.

They are of opinion, however, that the ordinary movements even of many persons in a room are not sufficient to produce any marked change in the numbers of organisms.

Dust from the House was shown to contain about 2,000,000 organisms per cubic centimetre. It is obvious from such figures how great a contamination of the air might be brought about by the disturbance of this dust in sweeping.

The Debating Chamber.

In view of the data concerning the numbers of the micro-organisms in the air of schools, the open situation, cleanliness, and mechanical ventilation of the Debating Chamber, together with the fact that comparatively little disturbance of the atmosphere is caused, would lead to the expectation that few bacteria would be found in the air of the Chamber in spite of the age of the building. Experiments XV—XXXIV show that the mean number in the Chamber itself in the four sets of experiments was only 5·8, a number only slightly in excess of that of the outside air, and even slightly lower than the average found by Frankland in July for outside air. Comparison with the figures already given brings out the fact that in the chamber there are fewer organisms than in any of the mechanically ventilated schools with one exception. Detailed examination of the figures quoted by Carnelley [1] shows that of the twelve mechanically ventilated school rooms examined by him three had lower figures, and of the 131 naturally ventilated rooms only two had a smaller number.

It may, therefore, be said that the air of the Chamber is, as regards the micro-organisms present, exceptionally pure.

Committee, Dining, and Smoking Rooms.

With one exception, namely the method of ventilation, these rooms are under the same conditions as the Chamber in regard to the factors which have an influence on the numbers of the micro-organisms, and it might be fairly deduced that if the ventilation were as efficient, the organisms would be as few.

During the taking of the sample in Committee Room No. 9 (XXXVI) 150 persons were present, and the fans were working. The number found, 20·9, though considerably greater than the mean in the Chamber, is very little above that given for mechanically ventilated schools.

In Committee Room No. 1 (XXXVII, XXXVIII) only 41 persons were present, the windows were open, but no fans were working. The mean of two experiments showed 34·6 bacteria. The mean of experiments in the Central Dining Room showed 43·2 (XXXIX, XL), and the Members' Smoking Room 30·6 (XLI).

In all these rooms with the exception of Committee Room No. 9, the numbers considerably exceed those quoted for mechanically ventilated schools, and even No. 9 is slightly in excess of the standard of purity suggested by Carnelley, Haldane and Anderson [2] for dwelling houses and schools. These observers consider that the limit of 20 organisms per litre should not be exceeded, nor the ratio 30 of bacteria to moulds. The latter ratio in these observations is, however, not exceeded, it being only 3·6.

From the foregoing considerations it would seem that the unsatisfactory condition of these rooms in regard to the number of bacteria is due to insufficient ventilation.

In the passages through which the air passes to the Chamber very few organisms were found, as shown in experiments VIII—XIII, and near the floor of the Chamber when no sitting was in progress (XIV) only 2·6, about half the mean number during sittings, were discovered.

Identification of Bacteria.

After the numerical calculations had been made from the gelatin plates, subcultures were sown into gelatin tubes from dissimilar colonies. These subcultures were grown at room temperature, and subsequently each was planted in the following media, gelatin stabs, potato, broth, glucose broth, nitrate and rosolic acid solutions, and milk. In these several media the morphological appearances of the organisms, the characteristics of their growth, and their power of producing acid, reducing nitrates, decolourising rosolic acid and curdling milk were noted. Further, each organism was tested for its power of forming gas, and finally the result of subcutaneous inoculation of 1 c.c. of a broth culture, grown for 48 hours or more, into a guinea-pig was observed.

Species which occurred on agar plates grown at 37° C. were similarly tested. (See Parliamentary paper referred to by Butterfield in the preceding paper p. 486 for details of species found.)

No bacteria were found which showed any discernible growth on blood serum in 24 hours at 37° C. and only two which grew anaerobically on agar at the same temperature. The results in these cases were probably due to the small quantities used for these cultivations, and in the latter also to the fact that in the majority of instances the tubes were soon overgrown with moulds.

The majority of the colonies which appeared on gelatin consisted of micrococci of various kinds. Bacilli were not so common. No spirilla were found, and moulds and yeasts were not identified.

From a considerable number of pure cultures, 20 species of bacilli and 27 of cocci were isolated. These, however, probably do not include all the species which were present on the plates, as some must have been overlooked in making the subcultures.

By the methods of cultivation employed in the course of these experiments no pathogenic bacteria associated with specific diseases in man were discovered, but certain organisms were found capable of producing various lesions and even death in guinea-pigs when injected subcutaneously[1].

Conclusions.

1. The number of micro-organisms in the open space surrounding the Houses of Parliament is comparatively small (4·2 per litre on the ground level).

2. At the top of the Tower there are only about one-third of the number found at the ground level.

3. From a bacteriological point of view the air in the Debating Chamber during a sitting is under the circumstances remarkably pure (5·8 per litre as a mean of 11 experiments).

4. The numbers found in the Committee, Dining, and Smoking Rooms were several times as great as in the Chamber (32·3 per litre as a mean of 6 experiments).

5. No organisms associated with specific diseases in man were isolated, and only a few pathogenic to animals.

[1] See p. 512.

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