

STUDIES IN THE COMMON COLD.*

I. OBSERVATIONS OF THE NORMAL BACTERIAL FLORA OF NOSE AND THROAT WITH VARIATIONS OCCURRING DURING COLDS.

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INTRODUCTION.

Although the problem of the common cold is now fully recognized as most important, no completely acceptable explanation of its causation has been presented. If we exclude the group of cold-like disturbances of allergic origin, the consensus of opinion is that the common cold is infectious in nature; but the work of many investigators has as yet failed to assign the etiological rôle to any one microorganism.

From time to time a causative relationship has been ascribed to a variety of bacteria. Pfeiffer (1), Voorhees (2), Tunncliff (3), Cecil (4), Cautley (5), Mackey (6), Floyd (7), and others have attempted to implicate one or more of the following organisms: *Micrococcus catarrhalis*, diphtheroids, streptococci, staphylococci, *B. Pfeifferi*, pneumococci, and various anaerobes. The work of these investigators has been open to criticism largely because of their failure to include adequate control studies of the normal flora of the nose and throat. Kruse (8), and later Foster (9), reported the successful transmission of colds by the inoculation of healthy individuals with nasal washings, obtained from colds, which had been passed through Berkefeld filters; the latter described the cultivation of minute "globoid" organisms to which he assigned the causative rôle. Schmidt (10), Williams *et al.* (11), Branham and Hall (12), and Robertson and Groves (13) failed to confirm these results. More recently Olitsky and McCartney (14) have again carried out similar successful transmission experiments; they failed to obtain the "globoid

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bodies" described by Foster, but did recover three types of filter-passing Gram-negative bacilli to which, however, they assigned no etiological rôle in view of their incidence in normals (15).

In searching for the causative agent in respiratory disease, the problem is seriously complicated by the fact that the nose and throat normally harbor a variety of organisms, some more or less constantly present and others transient in nature. In order, therefore, to interpret correctly the importance of bacteria present in respiratory disease, it is imperative that the investigator be conversant with the normal flora in health.

To this end, Williams *et al.* (11), in their intensive study of respiratory disease, made a number of cultures from normals and compared these results with the findings in disease. Bloomfield (16) went a step further. He made a preliminary survey of the flora of a group of normals over periods of 1 to 3 months, and then studied the flora in a series of colds and compared the results in the two groups. Jordan (17) made a similar study over a period of 2 to 3 weeks.

In the present preliminary study we are reporting observations of the flora in a group of normals over a comparatively long period, and, with this background for comparison, determinations of the quantitative and qualitative changes, if any, that took place in the course of the colds occurring in the group. We have been particularly interested in (1) what constitutes the normal flora of the nose and throat, (2) the incidence of potential pathogens and their significance, and (3) the variations from normal in the course of colds.

Methods.

Material.—Thirteen individuals were studied between October, 1924, and June, 1925. Of these, six were followed approximately 9 months, and seven from 4 to 5 months. Five were physicians, three working in the bacteriological laboratories and two in the chemical, and all in frequent contact with patients suffering from infectious diseases of all sorts; two were laboratory assistants, one bacteriological and one chemical; six were nurses on active ward duty.

Frequency of Cultures.—Cultures were made weekly when the individuals were in normal health, and daily when colds occurred; in addition, a few daily cultures were taken when sore throats or tonsillitis made their appearance.

Sources of Culture Material.—Nasal cultures were obtained by passing slightly curved sterile cotton swabs (on wire) well back into the nostril, using great care to avoid contact with the external nares. Throat cultures were made by passing curved swabs over the posterior pharyngeal wall, up behind the soft palate, and over the fauces and tonsils.

Cultural Methods.—Both aerobic and anaerobic cultivation were carried out in most instances during the first half of the work; later, when the group was enlarged,

anaerobic cultures were done once a month. Anaerobiosis was obtained with the Brown modification (18) of the McIntosh and Fildes jar (19), the indicator being methylene blue in 1 per cent dextrose broth.

The culture material, obtained as noted above, was immediately rubbed on fresh 5 per cent rabbit blood agar plates; the same swab was used for both aerobic and anaerobic plating. Streaking was done with sterile bent glass rods. This method gave satisfactory discrete colonies and it was not found necessary to resort to any system of dilution.

Aerobic plates were examined after 20 to 24 hours and were studied again after 48 hours. Anaerobic plates were examined after 5 to 7 days. Each type of colony was fished and the organisms identified. This was done by plate inspection, morphological study, and complete bacteriological study whenever indicated. At the time of examination, the predominating and the second most common organisms were determined.

Classification of Bacteria.—Gram-negative cocci were taken as a group, strain differentiation not being attempted. Streptococci were classified as hemolytic and non-hemolytic. Staphylococci, both hemolytic and non-hemolytic, were classified according to their pigment formation. A large Gram-positive staphylococcus-like organism which grew in large, dull greyish colonies was designated as "large Gram-positive coccus" (16). Pneumococci were occasionally noted. This organism was searched for carefully and the low incidence may be attributed to the fact that mouse inoculation was not practiced. All strains of diphtheroids were placed in one group. All hemophilic Gram-negative bacilli were grouped as *B. influenzae*, except the hemolytic type which was designated as Bacillus "X" (Pritchett and Stillman (20)).

RESULTS.

Graphic representation of the findings in the group studied is presented in Figs. 1 to 9. Brief discussions of each case accompany the charts. In the figures, the predominating organisms are shown by solid black circles and organisms with the second most numerous colonies, by blank circles; the presence of all other organisms is indicated by a plus sign.

Case 1 (K. C. M.), Fig. 1, was studied from October to June, inclusive. Two colds and one sore throat occurred during the period.

Normal Flora.—(1) *Nose:* *Staphylococcus albus*, present in 94 per cent of cultures, predominated. Diphtheroids were second most prominent (76 per cent). *Staphylococcus aureus* (30 per cent) occasionally predominated. Non-hemolytic streptococci and *Staphylococcus citreus* occurred once each. (2) *Throat:* Gram-negative cocci occurred in all cultures and usually predominated. Non-hemolytic streptococci occurred in all cultures, predominated a few times, but usually were

second in point of view of number of colonies. Bacillus "X" and diphtheroids were present in over half the cultures. Other bacteria were, "large Gram-positive coccus" (39 per cent), *Staphylococcus albus* (30 per cent), *citreus* (15 per cent), and *aureus* (12 per cent); pneumococci were found four times (12 per cent).

Colds.—The first cold (April) was moderately severe and was associated with a secondary bronchitis which required hospitalization. *Nose cultures* in the first 3

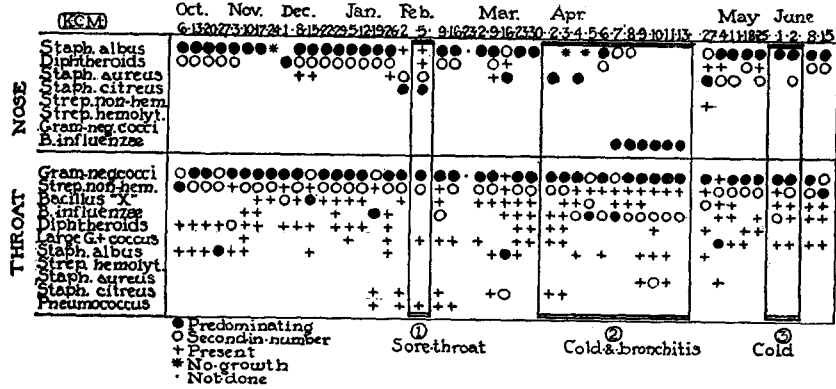


FIG. 1. Case 1. Graphic presentation of bacterial flora of nose and throat, normal, and during colds and throat infections.

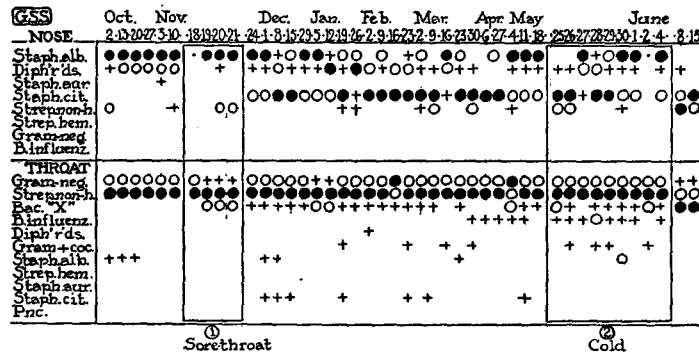


FIG. 2. Case 2.

days showed scanty growth with *Staphylococcus aureus* replacing all other organisms; on the 6th day *B. influenzae* appeared and was present in pure culture on the 8th, 9th, 10th, and 11th days. *Throat cultures* showed little general change during the first 2 days. On the 3rd day *B. influenzae*, which had been present before, became very prominent and remained so thereafter; at the same time the non-hemolytic streptococci decreased in numbers. *Staphylococcus aureus* appeared on

the 9th day and was very prominent on the 10th. Influenza bacilli were prominent in the sputum obtained upon coughing. No new or unusual organisms were noted in the early phases of the cold. The influenza bacilli, occurring at the period of secondary infection, may well be considered important secondary invaders.

The second cold (June) was of short duration. Aside from scanty growth in the nasal culture of the 1st day and in throat cultures of the 1st and 2nd days, and the prominence of *B. influenzae* on the 1st day, no noteworthy change in the flora occurred. No new or unusual organisms were present.

Sore Throat.—This was mild and was associated with the presence of pneumococci in the throat cultures for 3 weeks preceding the onset.

Case 2 (G. S. S.), Fig. 2, was studied from October to June. One cold and one sore throat occurred during the period.

Normal Flora.—(1) *Nose:* *Staphylococcus citreus* (81 per cent) and *albus* (78 per cent) predominated about equally; diphtheroids (90 per cent) were next most

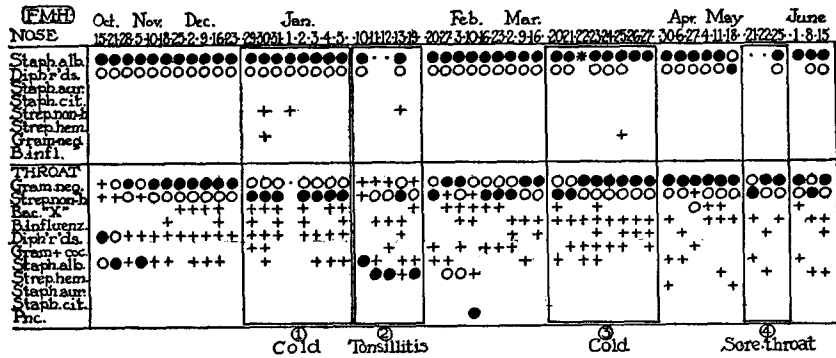


FIG. 3. Case 3.

prominent; non-hemolytic streptococci, long chains, were frequently present (32 per cent). Growth was usually very plentiful. (2) *Throat:* Non-hemolytic streptococci were present in all cultures and nearly always predominated. They frequently resembled pneumococci morphologically but were not bile-soluble nor pathogenic for white mice. Gram-negative cocci (100 per cent) were second most prominent. Bacillus "X" was common (68 per cent) and occasionally predominated. Less frequently noted organisms were, *Staphylococcus citreus* (25 per cent), *albus* (19 per cent), *B. influenzae* (16 per cent), "Gram-positive cocci" (12 per cent), and diphtheroids (3 per cent).

Cold.—A moderately severe cold with a secondary bronchitis occurred in May. *Nose cultures* showed no variation from the normal flora. *Throat cultures* showed slight increase in prominence of *B. influenzae*, which was present throughout, and prominence of *Staphylococcus albus* on the 6th day.

Sore Throat.—This was moderately severe and was accompanied by constitutional symptoms. It was associated with the first appearance of Bacillus "X" which was very prominent on the 2nd, 3rd, and 4th days. This was the first occurrence of the organism in the group. Its appearance in the others occasioned no untoward symptoms.

Case 3 (F. M. H.), Fig. 3, was studied from October to June. He had two colds, one attack of tonsillitis, and one sore throat.

Normal Flora.—(1) *Nose:* *Staphylococcus albus* occurred in all cultures and diphtheroids in 97 per cent; the former predominated every time but once. No other organisms appeared normally. The growth was usually very plentiful. (2) *Throat:* Gram-negative cocci and non-hemolytic streptococci occurred in all cultures. The former usually predominated. Other organisms were *Staphylococcus albus* (52 per cent), diphtheroids (52 per cent), Bacillus "X," and *B. influenzae* (45 per cent), hemolytic streptococci (21 per cent), a little high, "large

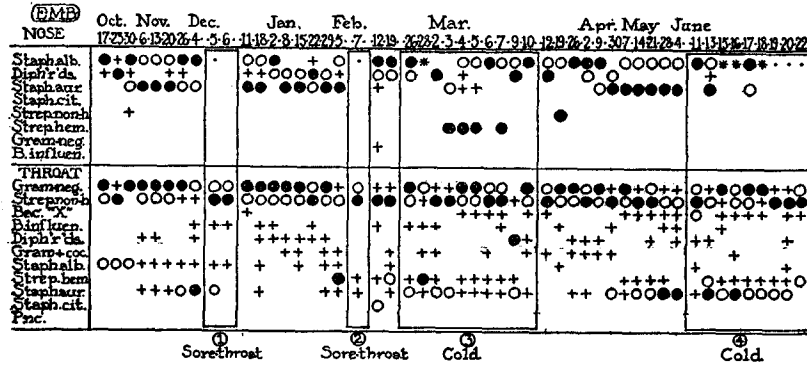


FIG. 4. Case 4.

Gram-positive cocci" (21 per cent), and *Staphylococcus aureus* (6 per cent). Pneumococci occurred and predominated once (Type IV) and were not accompanied by untoward manifestations.

Colds.—(1) This was a moderately severe cold (January) associated with a secondary bronchitis. *Nose cultures* showed scanty growth early; the general distribution was unaffected. Spread of Gram-negative cocci to the nose was noted once, of non-hemolytic streptococci twice. *Throat cultures*, Gram-negative cocci, usually predominating, were supplanted by non-hemolytic streptococci throughout. "Large Gram-positive cocci" made their first appearance on the 1st and 2nd days of the cold. No unusual organisms were noted.

(2) The second cold (March) was a typical one beginning in the throat. *Nose cultures:* Growth was scanty or absent early, Gram-negative cocci spread to the nose on the 6th day. *Throat cultures* showed no noteworthy changes. There were no new or unusual organisms present.

Tonsillitis.—This was a severe follicular tonsillitis requiring bed treatment. *Nose cultures:* No changes other than the spread of non-hemolytic streptococci on the 4th day. *Throat cultures:* The findings here were a little unusual. On the 1st day *Staphylococcus albus* was present in almost pure culture. On the 2nd day and thereafter hemolytic streptococci predominated. This sudden change was very striking.

Sore Throat.—This was very painful, showed acute pharyngeal inflammation and no constitutional symptoms. *Nose cultures:* No changes noted. *Throat cultures:* The variety of organisms was reduced and hemolytic streptococci were present on the 2nd day.

Case 4 (E.M.B.), Fig. 4, was studied from October to June. Two colds and two sore throats occurred during the period.

Normal Flora.—(1) *Nose:* *Staphylococcus aureus* (83 per cent) and *albus* (89 per cent) predominated about equally. Diphtheroids were frequent (66 per cent). Non-hemolytic streptococci and Gram-negative cocci appeared rarely. Growth was usually not very plentiful. (2) *Throat:* Gram-negative cocci, present in practically all cultures, predominated, while non-hemolytic streptococci (100 per cent) were second most prominent. *Staphylococcus aureus* was unusually frequent (58 per cent) and occasionally predominated. Other organisms present were *Staphylococcus albus* (58 per cent), diphtheroids (45 per cent), "large Gram-positive cocci" (38 per cent), *B. influenzae* (31 per cent), Bacillus "X" (24 per cent), hemolytic streptococci (24 per cent), a little high, and *Staphylococcus citreus* (3 per cent).

Colds.—(1) A moderately severe cold (March) with sore throat which persisted on and off for a long time subsequently. *Nose cultures:* Growth was scanty at first and then increased. Hemolytic streptococci appeared and predominated on the 4th, 5th, 6th, and 8th days. This was an unusual finding. *Throat cultures:* The only noteworthy change was the prominence of both hemolytic streptococci and *Staphylococcus aureus*, organisms which had been present less frequently in preceding normal cultures. No new or unusual organisms were noted, at the onset.

(2) A moderately severe cold with a complicating laryngitis (June). *Nose:* The only change noted was scanty growth early. *Throat cultures:* Hemolytic streptococci increased; *Staphylococcus aureus* was very prominent but had been so in the normal cultures preceding the cold.

Sore Throats.—(1) Mild. *Nose cultures* not done. *Throat cultures:* *B. influenzae* made its first appearance on the day preceding, was present during the sore throat, and was frequent in normal cultures thereafter.

(2) Mild. This was associated with the sudden first appearance of hemolytic streptococci, predominating, on the day preceding. This organism was frequently present in normal cultures after this.

Case 5 (D. W. A.), Fig. 5, was studied from October to June. He had no colds and no sore throats.

Normal Flora.—(1) *Nose:* *Staphylococcus albus* and diphtheroids were present in practically all cultures, the former usually predominating. *Staphylococcus aureus* was often present (45 per cent), and occasionally predominated. Non-hemolytic streptococci occurred occasionally. *Throat:* Gram-negative cocci, present in all cultures, strongly predominated. Non-hemolytic streptococci (100 per cent) were usually second in prominence. *B. influenzae* was very frequently present (78 per cent) and occasionally predominated. Other organisms were

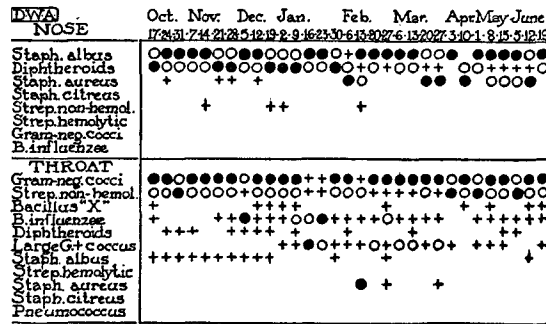


FIG. 5. Case 5.

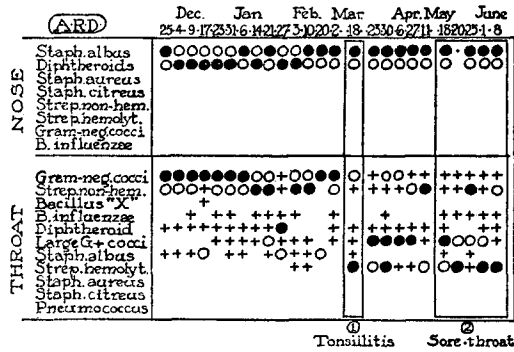


FIG. 6. Case 6.

"large Gram-positive cocci" (56 per cent), *Staphylococcus albus* (45 per cent), diphtheroids (38 per cent), Bacillus "X" (31 per cent), and *Staphylococcus aureus* (13 per cent).

Case 6 (A. R. D.), Fig. 6, was studied from December to June. He had one attack of tonsillitis and one chronic sore throat.

Normal Flora.—(1) *Nose:* *Staphylococcus albus* and diphtheroids were practically always present, the former usually predominating. No other organisms appeared. (2) *Throat:* Gram-negative cocci and non-hemolytic streptococci were always

present, the former predominated most often. "Large Gram-positive cocci" were very frequent (79 per cent) and occasionally predominated. Diphtheroids (84 per cent) and hemolytic streptococci (40 per cent) had a higher incidence than was usual in the group. Other organisms were *Staphylococcus albus* (58 per cent), *B. influenzae* (47 per cent), and Bacillus "X" (5 per cent).

Tonsillitis.—Because of absence from the clinic, one culture only, at the end of the attack, was possible. The only noteworthy finding was the predominance of hemolytic streptococci in the throat culture.

Sore Throat.—This was a chronic inflammation of several weeks duration. *Nose cultures* showed no variation from the normal flora. *Throat cultures* showed hemolytic streptococci predominating with "large Gram-positive cocci" second most prominent. Gram-negative cocci and non-hemolytic streptococci were markedly reduced in numbers. *B. influenzae* was a constant finding.

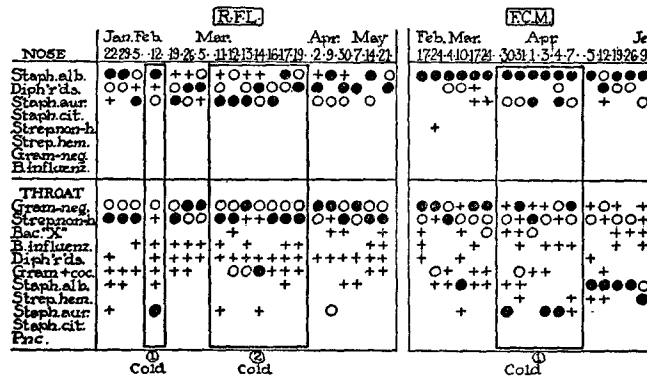


FIG. 7. Cases 7 and 8.

Case 7 (R. F. L.), Fig. 7, was studied from January to May. He had two colds.

Normal Flora.—(1) *Nose*: *Staphylococcus albus* (92 per cent), *aureus* (89 per cent), and diphtheroids (75 per cent) were the organisms present. Diphtheroids predominated most often, then *albus* and *aureus* in order. Growth was usually very plentiful. (2) *Throat*: Non-hemolytic streptococci and Gram-negative cocci were nearly always present, the former usually predominating. Diphtheroids (89 per cent) were high. Other organisms were "large Gram-positive cocci" (58 per cent), *B. influenzae* (50 per cent), *Staphylococcus albus* (33 per cent), *aureus* (17 per cent), and Bacillus "X" in 25 per cent of cultures.

Colds.—(1) The first (February) was a short uncomplicated cold. It was not reported early and only one late culture was obtained. *Nose culture* showed no unusual changes. *Throat cultures*: *Staphylococcus aureus* had become the predominating organism.

(2) A moderately severe cold with laryngitis (March). *Nose cultures*: *Staphylococcus aureus* became prominent from the very beginning. *Throat cultures*: "Large

Gram-positive cocci" became a little more prominent than usual on the 2nd and 4th days. No change in the general flora and no new or unusual organism noted.

Case 8 (F. C. M.), Fig. 7, was studied from February to June. She had one cold.

Normal Flora.—(1) Nose: *Staphylococcus albus* occurred in all cultures and markedly predominated. Diphtheroids were second most prominent. Other

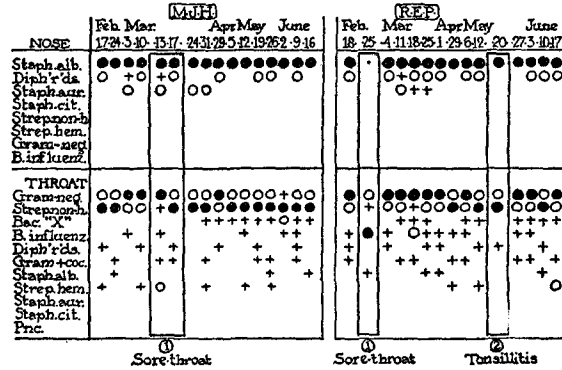


FIG. 8. Cases 10 and 11.

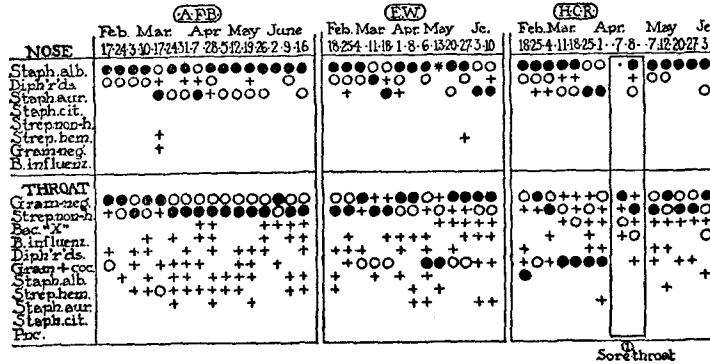


FIG. 9. Cases 9, 12, and 13.

organisms were *Staphylococcus aureus* (34 per cent), and non-hemolytic streptococci (9 per cent). (2) Throat: This was unusual. *Staphylococcus albus* was always present, and usually predominated. Gram-negative cocci (91 per cent) were second most prominent and non-hemolytic streptococci were always present. Other organisms were Bacillus "X" (55 per cent), "large Gram-positive cocci" (44 per cent), *B. influenzae* (34 per cent), hemolytic streptococci (27 per cent), high, diphtheroids (27 per cent), and *Staphylococcus aureus* (9 per cent).

Cold.—This (April) was severe and was complicated by bronchitis and sinusitis. *Nose cultures:* *Staphylococcus aureus* became unusually prominent and remained so throughout. *Throat cultures:* *Staphylococcus aureus* was prominent from the beginning; *albus* was less conspicuous than usual.

TABLE I.
Percentage Incidence of Bacteria in the Noses and Throats of Normals.

Cases.	Total cultures (weekly).	Nose.						Throat.											
		Organisms.						Organisms.											
		<i>Staphylococcus albus</i> .	Diphtheroids.	<i>Staphylococcus aureus</i> .	<i>Staphylococcus citreus</i> .	Streptococcus non-hemolytic.	Gram-negative cocci.	Streptococcus hemolytic.	Gram-negative cocci.	Streptococcus non-hemolytic.	Bacillus "X."	<i>B. influenzae</i> .	Diphtheroids.	"Large Gram-positive cocci."	<i>Staphylococcus albus</i> .	Streptococcus hemolytic.	<i>Staphylococcus aureus</i> .	<i>Staphylococcus citreus</i> .	Pneumococci.
1. K.C.M.	33	94	76	30	3	3		100	100	64	42	60	39	30		12	15	12	
2. G.S.S.	31	78	90	3	81	32		100	100	68	16	3	10	19			25		
3. F.M.H.	29	100	97					100	100	45	45	52	21	52	21	6		3	
4. E.M.B.	29	87	67	83		7	3	97	100	24	31	45	38	48	24	58	3		
5. D.W.A.	32	97	97	45		12		100	100	31	78	38	56	45		13			
6. A.R.D.	19	100	95					95	100	5	47	84	79	58	40				
7. R.F.L.	12	92	75	89				100	100	25	50	89	58	33		17			
8. F.C.M.	11	100	55	34		9		91	100	55	34	27	44	91	27	9			
9. A.F.B.	16	100	63	75			6	100	100	38	44	56	56	63	69	19			
10. M.J.H.	14	100	50	21				100	100	57	29	35	35	21	35				
11. R.E.P.	13	100	84	23				100	100	69	69	46	61	23	23				
12. H.C.R.	12	100	58	58				100	100	75	25	42	83	17	8	8			
13. E.W.	14	93	71	50				100	100	36	64	43	78	29	21	29			
Average, per cent.....		92	79	36	10	7	1	0.4	99	99	49	47	45	45	40	17	14	5	2

Cases 9 to 13, Figs. 8 and 9, were studied from February to June. They developed no colds. Three had sore throats.

Normal Flora.—(1) *Nose:* In all cases *Staphylococcus albus* predominated. All had diphtheroids and *Staphylococcus aureus*, three showing the former second most prominent, and two the latter, Gram-negative cocci appeared in two, and one showed a hemolytic streptococcus once. (2) *Throat:* Three had non-hemolytic streptococci predominating and Gram-negative cocci second. This order was reversed for the other two. Hemolytic streptococci were high in two, A. F. B., 69 per cent, and M. J. H., 35 per cent. Other findings were essentially similar to the previous cases discussed.

Sore Throats.—These were four in number, of varying severity. Hemolytic streptococci were prominent in one of these (M. J. H.). Otherwise no noteworthy departures from normal findings were observed.

Summary of Results.

Normal Cultures.—A summary of the percentage incidence of all organisms obtained in cultures from the noses and throats of normal individuals is detailed in Table I. The total number of cultures per person appears in the first column; both aerobic and anaerobic cultures are combined as one. The organisms are arranged in order of greatest average occurrence.

In the consideration that follows, an attempt is made to divide the bacteria into those that are practically always present, essential or basic normal flora; and those that are frequently or occasionally present, temporary or transient flora. Consideration is given also to the presence of organisms to which pathogenic rôles are often attributed.

Nose.—The essential normal flora includes *Staphylococcus albus*, occurring in 92 per cent of cultures, and diphtheroids, 76 per cent. The former nearly always predominated. This is in agreement with Bloomfield's findings (21). In some individuals, however, certain other organisms were practically as frequent. In Cases 4, 7, and 9, *Staphylococcus aureus* was present in 75 to 89 per cent, and in Case 2, *Staphylococcus citreus* was found in 81 per cent. For these individuals these organisms may well be accorded the place of basic normal flora. A less likely explanation would be that these constitute an exaggerated carrier state, although no apparent foci of infection were present. Transients included non-hemolytic streptococci occasionally (high in Case 2, 32 per cent) and rarely, Gram-negative cocci and hemolytic streptococci.

So called potential pathogens were found in normal cultures only once, hemolytic streptococci in Case 9. There were no associated untoward symptoms.

Throat Cultures.—The basic flora includes Gram-negative cocci and non-hemolytic streptococci which appeared in practically all cultures. The former predominated in 55 per cent and the latter in 33 per cent of the cultures. This is in accord with Bloomfield's

findings (16). As in the case of the nose cultures, certain other organisms are unusually prominent in some individuals, again perhaps assuming a place among the essential flora. *B. influenzae*, for example, was present in 64 to 78 per cent of cultures from Cases 5, 11, and 13; Bacillus "X" in 55 to 75 per cent, in Cases 1, 2, 8, 10, 11, and 12. Diphtheroids ranged from 56 to 89 per cent in Cases 1, 6, 7, and 9; and "large Gram-positive cocci" were present in 56 to 83 per cent, in Cases 5, 6, 7, 9, 11, 12, and 13. One hesitates a little in including these organisms under the head of general basic flora; and yet, for certain individuals this assignation seems correct, although for others the organisms belong to the class of frequent transients.

Intermediate between basic and transient flora comes *Staphylococcus albus* with an average incidence of 40 per cent. True transients include hemolytic streptococci, *Staphylococcus aureus* and *citreus*, and pneumococci.

Bacteria occasionally assumed to play pathogenic rôles had a high incidence in some of the cases. Hemolytic streptococci were very frequent in Case 9 who had neither colds nor sore throats, and in Case 8 where there was little apparent effect. Incidence was high in Cases 4 and 6 who had more or less continuous subacute inflammation of their throats. The organism was prominent in the colds of the former. *Staphylococcus aureus* was common in Case 4, and the organism was somewhat more prominent in her colds. Pneumococci were rare. In Case 1, their presence was associated with a mild sore throat 3 weeks after their initial appearance. In Case 3, their occurrence resulted in no untoward symptoms. High incidence of *B. influenzae* and of the hemolytic type, Bacillus "X," was not associated with any apparent increase in respiratory infection.

Cultures during Colds.—In studying the bacterial flora of colds an attempt has been made to determine (1) whether any new or unusual organisms are present to which an etiological rôle may be assigned, (2) the relationship, if any, to colds, of transient, so called potential, pathogens, and (3) the qualitative and quantitative changes in the usual flora in the course of colds.

In answer to the first question it may be stated that no bacteria were found in either the first or early cultures to which a causative rôle could be attributed. In Case 3 only, did an organism appear

for the first time in a first cold culture. This was a "large Gram-positive coccus" to which only slight significance can be assigned in view of its frequent occurrence in the usual essential flora. It is worthy of note, however, that its incidence in this individual's normal cultures was comparatively low (21 per cent).

Among the organisms to which a pathogenic rôle has been variously assigned, the following were noted, hemolytic streptococci, *Staphylococcus aureus*, and pneumococci. For purposes of discussion we may include also the influenza bacilli, both non-hemolytic and hemolytic (Bacillus "X").

TABLE II.

Average Percentage Incidence of Bacteria in Cultures from Normals, Colds, and Sore Throats.

	Nose.									Throat.									
	<i>Staphylococcus albus</i> .	Diphtheroids.	<i>Staphylococcus aureus</i> .	<i>Staphylococcus citreus</i> .	Streptococcus non-hemolytic.	Gram-negative cocci.	Streptococci hemolytic.	<i>B. influenzae</i> .	Gram-negative cocci.	Streptococcus non-hemolytic.	Bacillus "X."	<i>B. influenzae</i> .	Diphtheroids.	Gram-positive cocci.	<i>Staphylococcus albus</i> .	Streptococcus hemolytic.	<i>Staphylococcus aureus</i> .	<i>Staphylococcus citreus</i> .	Pneumococci.
Normal.....	92	79	36	10	7	1	0.4	—	99	99	49	47	45	45	40	17	14	5	2
Colds.....	73	52	28	12	8	3	6	9	99	99	57	67	39	43	27	26	40	4	—
Sore throats.	100	77	35	12	6	—	—	—	100	100	26	70	35	48	48	56	9	—	9

Table II shows a comparison of the percentage incidence of all organisms present in normal cultures, and those obtained during colds. It is interesting to note that practically all the potential pathogens enumerated above show an increase in either the nose or throat cultures.

Nose Cultures.—*Staphylococcus aureus* shows a decrease, paralleling *Staphylococcus albus* (normal basic flora). It should be noted that it was unduly prominent in the first cold of Case 1. *B. influenzae* and hemolytic streptococci show increases, which, however, are due chiefly to late secondary spread in Cases 1 and 4 respectively.

Throat Cultures.—*Staphylococcus aureus* shows considerable increase. This, however, is in part apparent as Case 4, with a high normal incidence and a correspondingly high incidence in her colds, is responsible for most of the raised average. This organism was prominent in two other colds; early in one and late in another. The increase of hemolytic streptococci was slight and constitutes secondary invasion. The occurrence of *B. influenzae* was definitely high during colds. This increase also is more or less apparent as part is due to the prominence of the organism in the secondary phases of

TABLE III.

Percentage of Predominance of Various Bacteria in Cultures from Normals and from Colds.

	Nose.										Throat.									
	<i>Staphylococcus albus.</i>	Diphtheroids.	<i>Staphylococcus aureus.</i>	<i>Staphylococcus citreus.</i>	Streptococcus non-hemolytic.	Gram-negative cocci.	Hemolytic streptococcus.	<i>B. influenzae.</i>	Gram-negative cocci.	Streptococcus non-hemolytic.	Bacillus "X."	<i>B. influenzae.</i>	Diphtheroids.	Gram-positive cocci.	<i>Staphylococcus albus.</i>	Streptococcus hemolytic.	<i>Staphylococcus aureus.</i>	<i>Staphylococcus citreus.</i>	Pneumococci.	
Normal.....	70	13	10	6	1	—	—	—	55	33	1	1	1	4	4	1	2	—	0.5	
Colds.....	57	6	15	6	—	—	6	10	39	46	—	3	1	1	—	1	9	—	—	

some of the colds, and part may be attributed to its uniformly high incidence in normal as well as cold cultures at the time of occurrence of most of the colds (late winter and spring). The moderate rise of Bacillus "X" is similarly due to its more widespread presence at the same time. Pneumococci played no part in the colds of the series.

Quantitative and qualitative changes occurred in the general and basic nature of the flora in most of the colds. In early cultures from the nose, scanty or even absent growth was moderately conspicuous. Such quantitative changes were not so noticeable in throat material. Qualitative changes were noticeable in both. Reference to Table II shows that the average incidence of the nasal normal basic flora, *i.e.* *Staphylococcus albus* and *aureus*, and diphtheroids, is decreased;

and the individual charts of cases show late increase in variety resulting from secondary spread.

In the throat cultures the incidence of basic organisms is unaffected but changes in their predominance are noticeable. Table III brings these out. From this it will be observed that the usually more prominent Gram-negative cocci fall off and that their conspicuous place is taken by non-hemolytic streptococci. On inspection of the cold plates, this was particularly striking. *Staphylococcus aureus* also rises a little in prominence. Another noteworthy change was the general tendency to an increase in the variety of organisms in later throat cultures.

Sore Throats.—The primary concern of this study was with colds. However, cultures were made in the course of tonsillitis and sore throats. The results are shown in the individual charts and in Table II. The positive findings were, in brief, no change in nasal cultures and the more or less expected striking increase, in throat cultures, of hemolytic streptococci, from 17 per cent in normals to 56 per cent in throat infections. The high incidence of *B. influenzae* may be accounted for on the same grounds as noted for colds. The possible relationship of pneumococci to throat infection in Case 1, and of Bacillus "X" in Case 2 has been referred to above.

SUMMARY AND CONCLUSIONS.

1. The normal bacterial flora of the nose and throat of thirteen individuals has been studied over periods ranging from 5 to 9 months.

2. Observations have been made of qualitative and quantitative changes in the flora occurring in the course of colds and of throat infections appearing in the group.

3. The normal basic nasal flora includes *Staphylococcus albus*, diphtheroids, and for certain individuals *Staphylococcus aureus* and *citreus*. Occasional transient bacteria are Gram-negative cocci and non-hemolytic streptococci.

4. The normal basic throat flora includes Gram-negative cocci, non-hemolytic streptococci, and for certain individuals "large Gram-positive cocci," *B. influenzae*, Bacillus "X," and diphtheroids. Transient organisms are *Staphylococcus albus*, hemolytic streptococci, *Staphylococcus aureus* and *citreus*, and pneumococci.

5. No bacteria were found in early cold cultures to which a causative rôle could be assigned.

6. In the course of colds the basic flora of the nose was often scanty in the early stages. The throat showed reduction of prominence or alterations in predominance of the basic flora.

7. Certain organisms were prominent in colds, usually as late or secondary invaders, these included *Staphylococcus aureus*, hemolytic streptococci, and *B. influenzae*.

8. There was a striking increase in the incidence of hemolytic streptococci in throat infections.

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