PROPOSAL FOR A CHANGE IN THE
NOMENCLATURE OF DIPLOCOCCUS PNEUMONIAE
AND A COMPARISON OF THE DANISH AND
AMERICAN TYPE DESIGNATIONS

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In some instances, certain tinctorial and cultural phenomena or fermentative reactions are sufficient for differentiation of bacteria; others require specific methods that have developed from the study of immunity. From the broad point of view of etiology, the drawing of such fine lines of division may be of minor significance, but from past experience with Diplococcus pneumoniae the fine points of differentiation have been of crucial importance in specific therapy (serum therapy) and of interest in importance epidemiologically. There is also merit in having simplified terminology to identify the elemental varieties of any organism. Names of species, for example, are binary combinations made up of the name of the genus followed by a single species appellation while names of subspecies are ternary combinations consisting of the name of the genus followed in order by the names of the species and subspecies.

In his paper, "Remarks on the Nomenclature and Classification of Bacteria", P.B. White(1) wrote the following: "It is reasonably clear that such an accepted genus as Salmonella, presenting types honored with specific names, is actually of the same order as Pneumococcus, treated usually as a single species enclosing numbered subtypes or varieties. Convenience, history, and the characters of the organisms themselves may favor this difference of treatment but the fact remains that the Salmonella type and the pneumococcus type are of equivalent natural status and are elementary species in the sense of de Vries, and that Salmonella and Pneumococcus are natural genera roughly defined by their R variants and by their basal proteins and polysaccharides.

The Committee might usefully reach a decision as to whether the taxonomic species should be established at the level of the elementary species or whether its size in different cases should continue to be dictated by convenience."

The subcommittee on Streptococci and Pneumococci of the International Bacteriological Nomenclature Committee discussed this problem at the Seventh International Microbiological Congress in Stockholm in 1958 and decided that the Pneumococcus was best regarded as a species within the genus Streptococcus. For the reasons stated above, however, the authors believe that the matter might be reconsidered and therefore propose that the taxonomic species be established for the pneumococcus at the level of the present species and that the serological types be regarded as species of the genus, Pneumococcus, in the same ways in which the serological Salmonella types are regarded as species of the genus Salmonella in the Kauffmann-White schema (2).

Nomenclature of the serological types of Pneumococcus has evolved along different lines. Bezançon and Griffon (3) in 1897 were the first to establish differences in serological behavior, using the serum of patients with pneumococcal infections. They concluded that from the standpoint of agglutination, several races of pneumococci existed and these behaved as though they were different microbes. Park and Williams (4) in 1905 classified Streptococcus mucosus (the present type 3) as a definite variety of Pneumococcus and Collins (5) in the same year also noted that Pneumococcus mucosus formed a distinct race and on the basis of absorption experiments was related more closely to Pneumococcus than to Streptococcus. In (1910) Neufeld and Haendel (6) demonstrated the full significant value of serological classification. They isolated and established Pneumococcus I as typical and one strain, "Franz", as atypical. Dochez and Gillespie (7) in 1913 divided the Pneumococcus into four groups; group I was the Pneumococcus I of Neufeld and Haendel, group II was identical with "Franz", group III was the specific, Pneumococcus mucosus, and group IV was a heterologous group. Lister (8) working with strains isolated in South Africa also published on the serological classification of pneumococci in 1913 and additional work was reported in 1916 (9) and 1917 (10). A total of 11 groups were described, A, B, C, D, E, F, G, H, J, K, and X. X in-

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cluded unclassified strains. Lister's groups B, C, and E corresponded to Dochez and Gillespie's groups II, I and III.

In 1915 Avery (11) further subdivided group II into three subgroups IIA, IIB and IIX. The next year Olmstead (12) confirmed the classification of Pneumococcus into types I, II and III and then separated members of group IV into 12 groups some of which contained subgroups. Subsequently she (13) suggested that some of these groups were related to both group II and group IV but because of a closer relation to the latter should be classed as group IV. The same proposal was made by Clough (14) concerning Avery's subgroups IIA and IIB since members of these groups possessed relatively low virulence for animals and had been recovered from the mouths of normal persons. Stillman (15) in 1919 divided type II into 12 subgroups. Groups IIa and IIh were usually found in connection with disease in contrast with groups such as IIB, IIc, IIf, and IIm which were found in the mouths of normal people. In 1921 Griffith (16) compared strains he had isolated with strains sent to him from the United States. He found the three specific types I, II, and III and he separated group IV into other types including the American IIA and IIB. In a subsequent publication (17) he suggested that IIA be changed to IVA, and IIB to IVB. In 1926 Hintz (18) apparently unaware that type II had been subdivided, reported that this American type was not a distinct group. Among others, he identified Streptococcus mucosus as type III, although strains of this microorganism were encountered that gave atypical reactions. Robinson (19) in a study of immunological reactions of type IV pneumococci obtained during an epidemic described 4 groups in 1927. In 1928, Sugg, Gaspari, Fleming and Neill (20) and Harris, Sugg and Neill (21) described an atypical type III.

There were additional reports on the serological classification of the Pneumococcus during the years 1921 to 1932, but a series of studies by Cooper and her coworkers (22) (23) and (24) finally dispelled the confusion regarding the classification of Type IV and established 29 separate and definite types, including the atypical subtypes of other investigators. Table I.

In 1940 Kauffmann, Mørch and Schmith (25) reported new serological types, some of which were related to Cooper's

types. Such related types were labeled as subtypes and grouped together, for example, group 7 included types 7, 7A, 7B and 7C since these types had one or more capsular antigens in common. Kauffmann prepared a table of capsular antigens that were thought to be the most important for diagnosis. Like the "Kauffmann-White schema" of Salmonella antigens it was intended as a table for diagnostic purposes and not as a list of all antigens. The list was also useful in preparing type specific sera. For example, if a serum reacted with types 20, 31, 33A, 35A, 35C and 42, it was sufficient to absorb with only one of the types since each type contained the reacting antigen 20b.

In 1941 Walter and her coworkers (26) described seventeen new types and following the system of nomenclature of Kauffmann designated certain of the types as subtypes. Mørch (27) in 1942 also reported new types as subtypes, but the nomenclature of some of the types described by Walter were changed. In discussing these new types she stated, "It is to be emphasized once more that all the new types entered here in various groups are independent types, just like Cooper's types". Additional new types or subtypes were described by Mørch or Lund in 1944, 1950, 1957, (28) (29) (30) (31). Eddy (32) (33) in describing new types in 1944 employed the terminology of Cooper designating every type by a number regardless of its close relationship to another type. This choice was made for three reasons: 1) the lack of a satisfactory definition for a subtype, since some subtypes had a broader antigenicity than the major type while others did not, 2) disagreements of other workers as to the subtype designation, and 3) the fact that certain types were related not to one but to two or even more other types.

It was believed that this system of identifying each type with a number would prove advantageous for further study of type interrelationship since it is easier to recognize new types than to determine where they belong in the antigenic scheme. The use of a number for each type did not prevent related types from being grouped together wherever possible or from being changed from one group to another when it was useful to do so. During the period when typing was necessary for institution of specific serum therapy type identification was successfully simplified by the combination of Cooper's 32 types into six groups. Antigenic

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formulas were unknown at the time so it is of interest that types 20 and 31, both of which contain the antigen 20b, were in different groups. Likewise types 18 and 23 which contain the 18b antigen were not in the same group. The usefulness of combinations of various type specific antiserum for different types was recognized by Eddy who proposed 14 combinations of her 75 types in 1944 (34). Based on quantitative studies of cross reactions in many immune sera, types most closely related were placed in the same group, with groups 1 and 2 containing the types that occurred with greatest frequency in the United States of America.

Representative strains of types or subtypes described by Lund after 1944 were studied by Eddy and there was agreement that these strains were antigenically different from other known types. Consistent with the system of identifying each type with a number, these strains were numbered by Eddy 76 to 81 respectively and because of the large number of types Arabic numerals were used instead of the Roman numbers that Cooper had employed.

In a study of representative American strains, Lund did not agree that types 47 and 62 which Eddy had found gave different cross reactions with types 29 and 52 were different. Both strains were classified as type 35A in the Danish system. This accounts for a total of 80 types or subtypes in the Danish list and 81 types in the American list.

Comparative terminologies of the two systems of nomenclature are shown in tables 2 and 3. It may be noted that with the one exception listed above there was agreement that the types or subtypes listed were different from other types. While Eddy's nomenclature is used in the United States, the Danish nomenclature is used in Europe. Large volumes of literature on the Pneumococcus have accumulated over the years and confusion would ensue if the nomenclature would be changed in one way or another. Therefore we propose that both systems of type designations be continued.

SUMMARY

It is proposed that the Diplococcus pneumoniae be considered as the genus Pneumococcus and the serological types as species. A brief history of the nomenclature of pneumococcal types and correlation of the Danish and American type designations are given.

Table 1. Correlation of some of the present Danish and American types with earlier type epithets.

Present Danish and American types	Earlier type epithets
1	I (Neufeld and Haendel) C (Lister)
2	Franz (Neufeld and Haendel) B (Lister) II (Dochez and Gillespie)
3	<u>Streptococcus mucosus</u> (Parke and Williams) <u>Pneumococcus mucosus</u> (Collins) E (Lister) III Dochez and Gillespie
4	<u>Pneumococcus</u> 10 (Griffith) IVB (Robinson) IV (Cooper)
5	11A (Avery) IVA (Clough) IVA (Griffith) V (Cooper)
6	11B (Avery) IVB (Clough) IVB (Griffith) VI (Cooper)
8	Atypical III (Sugg) and (Harris) IVA (Robinson) VII (Cooper)
15	<u>Pneumococcus</u> 98 (Griffith) XV (Cooper)
21	<u>Pneumococcus</u> 160 (Griffith) XXI (Cooper)
22	<u>Pneumococcus</u> 41 (Griffith) XXII (Cooper)

Table 2. Correlation of the Danish and American type designations with the antigenic formulas according to Kauffmann and Lund.

Denmark	Antigenic formulas	USA	Denmark	Antigenic formulas	USA
1	1a	1	20	20a, 20b, 7g	20
2	2a	2	21	21a	21
3	3a	3	22	22a, 22b	22
4	4a	4	22A	22a, 22c	63
5	5a	5	23	23a, 23b, 18b	23
6	6a, 6b	6	23A	23a, 23c, 15c	46
6A	6a, 6c	26	23B	23a, 23b, 23d	64
7	7a, 7b	51	24	24a, 24b, 24d, 7h	24
7A	7a, 7b, 7c	7	24A	24a, 24c, 24d	65
7B	7a, 7d, 7e, 7h	48	24B	24a, 24b, 24e, 7h	60?
7C	7a, 7d, 7f, 7g, 7h	50	25	25a, 25b	25
8	8a	8	27	27a, 27b	27
9A	9a, 9c, 9d	33	28	28a, 28b, 16b, 23d	28
9L	9a, 9b, 9c, 9f	49	28A	28a, 28c, 23d	79
9N	9a, 9b, 9e	9	29	29a, 29b, 13b	29
9V	9a, 9c, 9d, 9g	68	31	31a, 20b	31
10	10a, 10b	10	32	32a, 27b	32
10A	10a, 10c, 10d	34	32A	32a, 32b, 27b	67
11	11a, 11b, 11e, 11g	11	33	33a, 33b, 33d	70
11A	11a, 11c, 11d, 11e	43	33A	33a, 33b, 33d, 20b	40
11B	11a, 11b, 11f, 11g	76	33B	33a, 33c, 33d, 33f	42
11C	11a, 11b, 11c, 11d, 11f	53	33C	33a, 33c, 33e	39
12	12a, 12b	12	34	34a, 34b	41
13	13a, 13b	13	35	35a, 35b, 34b	35
14	14a	14	35A	35a, 35c, 20b	47, 62
15	15a, 15b, 15c, 15f	15	35B	35a, 35c, 29b	66
15A	15a, 15c, 15d, 15g	30	35C	35a, 35c, 20b, 42a	61
15B	15a, 15b, 15d, 15e, 15h	54	36	36a, 9e	36
15C	15a, 15d, 15e	77	37	37a	37
16	16a, 16b, 11d	16	38	38a, 25b	71
17	17a, 17b	17	39	39a, 10d	69
17A	17a, 17c	78	40	40a, 7g, 7h	45
18	18a, 18b, 18c, 18f	18	41	41a, 41b	38
18A	18a, 18b, 18d	44	41A	41a	74
18B	18a, 18b, 18e, 18g	55	42	42a, 20b, 35c	80
18C	18a, 18b, 18c, 18e	56	43	43a	75
19	19a, 19b, 19d	19	44	44a, 44b, 12b	81
19A	19a, 19c, 19d	57	45	45a	72
19B	19a, 19c, 19e, 7h	58	46	46a, 44b	73
19C	19a, 19c, 19f, 7h	59	47	47a, 35a, 35b	52

Table 3. Correlation of the American and Danish type designations.

USA	Denmark	USA	Denmark
1	1	41	34
2	2	42	33B
3	3	43	11A
4	4	44	18 A
5	5	45	40
6	6A	46	23A
7	7A	47	35A
8	8	48	7B
9	9N	49	9L
10	10	50	7C
11	11	51	7
12	12	52	47
13	13	53	11C
14	14	54	11B
15	15	55	18B
16	16	56	18C
17	17	57	19A
18	18	58	19B
19	19	59	19C
20	20	60	24B?
21	21	61	35C
22	22	62	35A
23	23	63	22A
24	24	64	23B
25	25	65	24A
26	6B	66	35B
27	27	67	32A
28	28	68	9V
29	29	69	39
30	15A	70	33
31	31	71	38
32	32	72	45
33	9A	73	46
34	10A	74	41A
35	35	75	43
36	36	76	11B
37	37	77	15C
38	41	78	17A
39	33C	79	28A
40	33A	80	42
		81	44

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