

THE GENUS *SALMONELLA* LIGNIÈRES, 1900

ISSUED BY THE SALMONELLA SUBCOMMITTEE OF THE NOMENCLATURE
COMMITTEE OF THE INTERNATIONAL SOCIETY FOR MICROBIOLOGY

INTRODUCTION

At the First Congress of the International Society for Microbiology held in Paris in July 1930, a Nomenclature Committee of the Society was authorised and constituted by resolution in plenary session. Under article 4 section *b* of the resolutions concerning the formation of the committee, authority and encouragement were given for the monographing of special groups or genera of bacteria. In furtherance of this object a subcommittee was called together early in 1933 to consider the question of the taxonomy and nomenclature of the Salmonella group, Dr H. Schütze, Lister Institute, London, being appointed Chairman; the other members of the subcommittee comprising: Dr E. O. Jordan, University of Chicago, U.S.A.; Dr F. Kauffmann, Statens Serum-institut, Copenhagen, Denmark; Dr W. M. Scott, Ministry of Health, London; Mr P. Bruce White, National Institute for Medical Research, London; with Dr R. St John-Brooks, National Collection of Type Cultures (Medical Research Council), Lister Institute, London, as Secretary. The late Dr J. Lignières, some time before his lamented death, consented to serve on the subcommittee. As, however, he died before he had an opportunity of considering the draft report, which he did not take part in drawing up, his name does not appear as a member of the subcommittee.

It is hoped that the report here presented may be the forerunner of others on similar lines.

The genus *Salmonella* was erected by Lignières, 1900, who employed the name for the organisms of the hog-cholera or "intermediate" group of the intestinal bacteria, the type species of the new genus being fixed by him in the following year (Lignières, 1901) as "le microbe du hog-cholera de Salmon." The name was used by Buchanan, 1918, as a designation for his second sub-genus of the genus *Bacterium* with the definition: "Fermenting glucose but not lactose with the formation of acid and gas. The type species is *Bacterium* (*Salmonella*) *cholerae suis*?" Castellani and Chalmers, 1919, recognised *Salmonella* as the sixth genus of the tribe Ebertheae with the following definition: "Ebertheae which completely ferment glucose, but do not ferment lactose and partially or completely ferment mannitol, in addition to other carbohydrates. Milk is not clotted. Type species: *Salmonella paratyphi* (Schottmüller)." Buchanan, 1925, states, however, that apparently Castellani and Chalmers were in error in fixing the type species. Bergey *et al.* 1923, defined the genus as follows: "Motile forms occurring in the intestinal canal of animals in various

types of acute inflammatory conditions. Attacks numerous carbohydrates with the formation of both acid and gas. In general does not form acetyl-methyl-carbinol. The type species is *Salmonella schottmülleri*." Bergey and his associates, however (Bergey *et al.* 1930), altered this definition as follows: "*Salmonella* Lignières, 1900. Motile or non-motile forms. Occur in the intestinal canal of animals in various types of acute, inflammatory conditions. Attack numerous carbohydrates with formation of both acid and gas except lactose, sucrose and salicin. In general do not form acetyl-methyl-carbinol. The type species is *Salmonella suispestifer* (Kruse) Lignières."

In the 4th edition of the *Manual of Determinative Bacteriology* (Bergey *et al.* 1934) this description is modified by admitting organisms that form acid only in carbohydrate media and by giving the authority for the type species as "(Kruse) Castellani and Chalmers."

Bruce White, 1929, defined the genus in the following terms: "A large genus of serologically related, Gram-negative and non-sporing bacilli; 0.4–0.6 μ \times 1–3 μ in usual dimensions, but occasionally forming short filaments; showing, with certain exceptions, a motile peritrichous phase in which they normally occur; in fact, adhering to the pattern of *B. typhosus* in staining properties and morphology. Failing to ferment lactose and saccharose, to clot milk, to liquefy gelatin or to produce indole, they regularly attack glucose with, but occasionally without, gas production. All the known species are pathogenic for man, animals, or both."

Previous to the erection of the genus *Salmonella* by Lignières in 1900 the members of this group of micro-organisms were included in the principal schemes of classification employed up to that time, either as *Bacterium* (Cohn, 1875; Flügge, 1886; Migula, 1894; Lehmann and Neumann, 1896) or as *Bacillus* (Trevisan, 1879; Migula, 1890). The generic name *Bacillus* should probably be restricted to spore-bearing bacteria, and, if we are to abandon the genus *Bacterium* in accordance with modern tendency in bacterial classification, and divide it into different generic groups, the generic name *Salmonella* has definite priority for the group in question. The members of the *Salmonella* subcommittee are in agreement on this question and accept the generic name *Salmonella* Lignières, 1900 for the group, with the definition of Bruce White as cited above. In their opinion the type species is: *Salmonella cholerae-suis* (Smith) *comb. nov.*

In submitting the following scheme of classification of the genus *Salmonella*, the members of the subcommittee wish to point out that so far as possible they have adhered to the International Rules of Botanical Nomenclature. In this connection they wish to acknowledge their indebtedness to Mr J. Ramsbottom, Keeper of Botany, British Museum (Natural History), and a member of the Nomenclature Committee of the International Society for Microbiology, who advised them on questions of citation. No departure has been made from the rule of priority, except in such cases as the original description of a genus has, in the light of subsequent knowledge, been found inadequate, or in which

the name itself has been used homonymously. In all cases the customary methods of citation have been followed, of which the following are examples:

I. Alterations made by a member of the subcommittee in the present publication (*combinatio nova*: new combination), as:

Salmonella thompson Scott, *comb. nov.*

II. When an author's name is put in parentheses it means that the species as named by him has been transferred to the genus *Salmonella* by the subcommittee, as:

Salmonella abortus-ovis (Schermer and Ehrlich), *comb. nov.*

or previously by some other authority and accepted by the subcommittee, as:

Salmonella typhi-murium (Loeffler) Castellani and Chalmers

or that a name, previously employed as a specific name, is retained by the subcommittee as a varietal name, as:

Salmonella senftenberg Kauffmann var. *newcastle* (Warren and Scott).

III. Square brackets indicate the source of a name where this would not otherwise be obvious, as:

Salmonella cholerae-suis (Smith) var. *kunzendorf* [Pfeiler] (Kauffmann).

In cases where names are not italicised it is an indication that they are merely trivial names used in the vernacular and therefore invalid.

Examples: "Paratyphusbacillus," "Bacille paratyphique," "Paratyphoid C. Bacillus."

The classification employed (The Kauffmann-White Schema) is based upon the taxonomic schema finally presented by Kauffmann, 1931, which is in itself a re-examination and amplification of the pioneer work of Schütze, Bruce White, Scott and others. The species recognised are taken in the order followed by Kauffmann, with a few minor alterations and additions. The names employed are those finally approved by the subcommittee. They are followed, in each case, by brief particulars of first isolation and by a list of the principal synonyms employed in the literature. The antigenic structure is indicated according to Kauffmann's method; the groups division being given in capital letters, the thermo-stable O-antigen indicated in Roman numerals, the specific H-antigen in small letters and the unspecific H-antigen in Arabic numerals. In the case of the discovery of new species comprising new antigenic types, the subcommittee recommends that this method should continue to be employed; the new O-antigens being designated as XI, XII, etc., the specific H-antigens as z_1 , z_2 , etc., and the unspecific H-antigens as 7, 8, etc.

For the future guidance of workers in this field it is suggested that, following recent practice, new serological types should receive specific names in accordance with the names of the places of their first occurrence. With regard to the admission of such new types of *Salmonella*, the subcommittee is fully alive to the undesirability of erecting new species on slight cultural or serological differences, and considers that the criteria to be observed should be

based on (a) distinctive cultural characters or (b) differences in the O-antigen and/or the specific phase of the H-antigen. There is no definite rule laid down by botanists as to the criteria to be employed in the formation of varieties within the species concept, but with regard to the genus *Salmonella* the subcommittee suggests that varietal names should be employed where slight, but consistent, cultural differences are correlated with identical antigenic structure (e.g. *S. senftenberg* and *S. senftenberg* var. *newcastle*, which are differentiated through the failure of the latter to form H₂S), or where organisms culturally similar and with the same O-antigen and specific H-antigen, show variation in the unspecific phase of the H-antigen (e.g. *S. newport* and *S. newport* var. *kottbus*), or absence of the specific phase in otherwise diphasic strains (e.g. *S. typhi-murium* and *S. typhi-murium* var. *binns*). The "Dublin," "Moscow" and "Rostock" types, although they differ in their specific H-antigens, have, however, been considered as varieties of *S. enteritidis* and not as separate species. This exception was adopted for purposes of simplification and is based on the fact that all the members of the species contain the characteristic "enteritidis" *g*-factor in their specific H-antigens and are similar in other serological and in cultural respects.

Dr E. O. Jordan has signed the report with the following reservation. In his opinion, certain of the dysentery bacilli, particularly the Flexner type, seem so closely related to the typhoid bacillus that they should not be separated from it in any classification broad enough to include the organisms grouped in the genus *Salmonella* in this report. He considers that this resemblance is manifested in the fermentation of dextrose and a number of other carbohydrates without gas production; in the absence of fermentation of lactose; in inability to liquefy gelatin; in colony formation on ordinary media, and also, and especially, on such differential media as Endo agar. The differences between the Flexner dysentery bacillus and the typhoid bacillus do not seem to him any more significant for the purposes of classification than the differences between the typhoid bacillus and some other members of the genus *Salmonella* as constituted in this report.

The other members of the *Salmonella* subcommittee, however, disagree entirely with Dr Jordan's view. It will be observed that most of the resemblances between *S. typhi* and the Flexner type of dysentery bacilli mentioned by Dr Jordan, are of a purely negative character and are shared by many other organisms manifestly unrelated to either *Salmonella* or dysentery bacteria. On the other hand, many of the positive resemblances between *S. typhi* and the other members of the *Salmonella* group are not shared by the Flexner group organisms. Culturally there is no greater difference between the typhoid bacillus and the remaining members of the *Salmonella* group than, for example, between the paratyphoid A bacillus and the Sendai type on the one hand, and the other representatives of the *Salmonellas* on the other. Moreover, a consideration of both the O- and H-antigens of the typhoid bacillus shows it to be a true member of the group. The morphological, cultural and patho-

The Kauffmann-White schema showing the antigenic structure of the various species of Salmonella recognised.

GROUP	Species	O-antigen	H-antigen		
			Specific	Non-specific	
GROUP A:	1 <i>S. paratyphi-A</i>	I, II	a	—	
	2 <i>S. senftenberg</i>		gs	—	
	3 <i>S. senftenberg var. newcastle</i> }	I, III	gs	—	
GROUP B:	4 <i>S. paratyphi-B</i>	IV, V	b	1, 2	
	5 <i>S. typhi-murium</i>		i	1, 2, 3	
	6 <i>S. typhi-murium var. binns</i> }		—	1, 2, 3	
	7 <i>S. stanley</i>		d	1, 2	
	8 <i>S. heidelberg</i>		r	1, 2, 3	
	9 <i>S. reading</i>	IV	eh	1, 4, 5	
	10 <i>S. derby</i>		fg	—	
	11 <i>S. abortus-equi</i> }		enx	—	
	12 <i>S. abortus-ovis</i>		c	1, 4, 6	
	13 <i>S. brandenburg</i>		enlv	—	
	GROUP C:		14 <i>S. paratyphi-C</i>	VI, VII	c
		15 <i>S. cholerae-suis</i>	c		1, 3, 4, 5
		16 <i>S. cholerae-suis var. kuzendorf</i> }	—		1, 3, 4, 5
17 <i>S. typhi-suis</i>		c	1, 3, 4, 5		
18 <i>S. typhi-suis var. voldagsen</i>		—	1, 3, 4, 5		
19 <i>S. thompson</i>		k	1, 3, 4, 5		
20 <i>S. thompson var. berlin</i>		—	1, 3, 4, 5		
21 <i>S. virchow</i>		r	1, 2, 3		
22 <i>S. oranienburg</i>		mt	—		
23 <i>S. potsdam</i>		enlv	—		
24 <i>S. bareilly</i>		y	1, 3, 4, 5		
25 <i>S. newport</i>		eh	1, 2, 3		
26 <i>S. newport var. puerto-rico</i> }		—	1, 2, 3		
27 <i>S. newport var. kottbus</i>		VI, VIII	eh		1, 3, 4, 5
28 <i>S. bovis-morbificans</i>			r		1, 3, 4, 5
29 <i>S. muenchen</i>	d		1, 2		
GROUP D:	30 <i>S. typhi</i>	IX	d	—	
	31 <i>S. enteritidis</i>		gom	—	
	32 <i>S. enteritidis var. danysz</i>		gom	—	
	33 <i>S. enteritidis var. dublin</i>		gp	—	
	34 <i>S. enteritidis var. rostock</i>		gpu	—	
	35 <i>S. enteritidis var. moscow</i> }		goq	—	
	36 <i>S. sendai</i>		a	1, 4, 5	
	37 <i>S. dar-es-salaam</i>		enlv	—	
	38 <i>S. eastbourne</i>		eh	1, 3, 4, 5	
	39 <i>S. panama</i>		lv	1, 3, 4, 5	
	40 <i>S. gallinarum</i>		—	—	
41 <i>S. pullorum</i>	—	—			
GROUP E:	42 <i>S. london</i>	X, III	lv	1, 4, 6	
	43 <i>S. anatum</i>		eh	1, 4, 6	
	44 <i>S. anatum var. muenster</i> }		eh	1, 4, 5	

genetic characters of the typhoid bacillus bring it into generic relationship with Gärtner's bacillus rather than with the dysentery bacilli, and in the opinion of the other members of the subcommittee this relationship is precisely confirmed and mapped out by their antigenic similarities with each other and with others grouped with them on generic grounds. In this connection the work of Bruce White, 1929 *a*, on "rough" relationships among the intestinal bacteria is of much significance. He found that *all* members of the *Salmonella* group of Kauffmann and White, as then constituted, were in one hundred per cent. agreement with each other in this respect, but none of them, not excepting the typhoid bacillus, showed more than a partial relationship, if indeed that, with those other intestinal bacteria which he examined.

It is admitted that the O-antigens of the *Salmonella* organisms may occur in other genera, for example, sporadically in the coli group and consistently in certain types of *B. pseudotuberculosis-rodentium* (Schütze, 1928); but these facts merely serve to indicate possibly phylogenetic relationships, as these organisms can be readily differentiated from members of the *Salmonella* group on morphological, cultural and pathogenetic grounds; or perhaps the presence of a common antigen in such diverse genera may be as strange and unaccountable as the Forssmann phenomenon. This belief in serology as the ultimate criterion in the taxonomy of the group is the consequence of the experience of the very great practical services serology has rendered, turning a field full of uncertainties and pitfalls into one in which identification has become easy, certain and closely correlated with pathology and epidemiology. It is not suggested that the classification of bacteria should be based on serological criteria alone. The true field of serology lies in differentiating between bacteria that are plainly related to each other on other grounds (morphology or general bionomics). Within a group so recognised the serological differences are so definite as to be valid in erecting species.

R. ST JOHN-BROOKS.

LIST OF SPECIES OF SALMONELLA RECOGNISED BY
THE SUB-COMMITTEE

GROUP A

1. *Salmonella paratyphi-A* (Brion and Kayser) *comb. nov.*

Antigenic structure I, II: a: —.

Isolated by Gwyn, 1898, Schottmüller in 1899, and Brion and Kayser, 1902, from cases of enteric fever.

Synonyms: "Typhusähnliche Bazillen" of Schottmüller, 1900 (one type); Paratyphusbazillus of Schottmüller, 1901 (one type); *Bacterium paratyphi* Typus A, Brion and Kayser, 1902; *B. paratyphosus A*, Boycott, 1906; *Salmonella paratyphosus A*, Bruce White, 1929-30; *Salmonella paratyphi*, Bergey *et al.* 1930; Typus A of Kauffmann, 1931.

2. **Salmonella senftenberg**, Kauffmann *comb. nov.*
 Antigenic structure I, III: gs: —.
 Isolated in 1928 by Kauffmann from food-poisoning cases.
 Synonyms: Typus-Senftenberg of Kauffmann, 1929, 1930; Typus-Senftenberg-Newcastle of Kauffmann, 1931.
 Presents cultural differences from *S. senftenberg* var. *newcastle*.
3. **Salmonella senftenberg** Kauffmann var. *newcastle* (Warren and Scott).
 Antigenic structure I, III: gs: —.
 Isolated by Warren from human excreta, Newcastle, England.
 Synonyms: *Salmonella newcastle*, Warren and Scott, 1929–1930; Typus-Senftenberg-Newcastle of Kauffmann, 1931.
 Presents cultural differences from *S. senftenberg*.

GROUP B

4. **Salmonella paratyphi-B** (Brion and Kayser) Warren and Scott.
 Antigenic structure IV, V: b: 1, 2.
 Isolated by Achard and Bensaude from “paratyphoid” cases, France.
 Synonyms: “Bacille paratyphique” of Achard and Bensaude, 1896; “Typhusähnliche Bazillen” of Schottmüller, 1900 (one type); Paratyphus-bazillus of Schottmüller, 1901 (one type); *Bacillus bremensis febris gastricae* of Kurth, 1901; *Bacterium paratyphi* Typus B, Brion and Kayser, 1902; *B. paratyphosus* B, Boycott, 1906; *B. paratyphosus* B Schottmüller type of Schütze, 1920; Group IV of Hecht-Johansen, 1923; *Salmonella paratyphosus* B, Ibrahim and Schütze, 1928, Bruce White, 1929–30; *Salmonella schottmülleri*, Bergey *et al.*, 1930; *Salmonella paratyphi* B, Warren and Scott, 1929–30, Schütze, 1930; Typus-Schottmüller of Kauffmann, 1931.
5. **Salmonella typhi-murium** (Loeffler) Castellani and Chalmers.
 Antigenic structure IV, V: i: 1, 2, 3.
 Isolated by Loeffler in 1890. Mouse epizootic.
 Synonyms: *Bacillus typhi murium*, Loeffler, 1892; *Bacterium psittacosis*, Nocard, 1893; *Bacillus Kaensche* and “Breslau Bacillus” of Kaensche, 1896; *Bacillus aertrycke*, De Nobele, 1899, 1901; *B. pestis-caviae*, Wherry, 1908; *Salmonella typhimurium*, Castellani and Chalmers, 1919; *B. paratyphosus* B Mutton type of Schütze, 1920; Group VII of Hecht-Johansen, 1923; *Salmonella aertrycke*, Ibrahim and Schütze, 1928, Warren and Scott, 1929–30, and Bruce White, 1929–30; “Mäusetyphus-Bacillus” and Bact. enteritidis Breslau of the German literature.
6. **Salmonella typhi-murium** (Loeffler) Castellani and Chalmers var. *binns* (Schütze).
 Antigenic structure IV, V: —: 1, 2, 3.
 Isolated by McNee in 1917 from case of food-poisoning, France (Binns).
 Synonyms: *B. paratyphosus* B Binns type of Schütze, 1920; Group VI of Hecht-Johansen, 1923; Typus-Binns of Kauffmann, 1931.

7. **Salmonella stanley** (Schütze) Warren and Scott.
 Antigenic structure IV, V: d: 1, 2.
 Isolated by Peck and Thompson, Chesterfield in 1911, and by Hutchens, Stanley in 1917. Food-poisoning.
 Synonyms: *B. paratyphosus* *B Stanley* type, Schütze, 1920; *Salmonella*-Type Stanley, Savage and Bruce White, 1925, Bruce White, 1926; *Salmonella stanley*, Warren and Scott, 1929–30; Typus-Stanley of Kauffmann, 1931.
8. **Salmonella heidelberg** (Habs) *comb. nov.*
 Antigenic structure IV, V: r: 1, 2, 3.
 Isolated by Habs, 1933. Food poisoning, Heidelberg.
 Synonyms: *Bact. enteritidis* Typ. Heidelberg, Habs, 1933.
9. **Salmonella reading** Schütze.
 Antigenic structure IV: eh: 1, 4, 5.
 Isolated from Reading water supply in 1916 by Schütze.
 Synonyms: *B. paratyphosus* *B Reading* type of Schütze, 1920; *Salmonella reading*, Schütze, 1930; Typus-Reading of Kauffmann, 1931.
10. **Salmonella derby** (Savage and Bruce White) Warren and Scott.
 Antigenic structure IV: fg: —.
 Isolated from food-poisoning cases in Derby by Peckham.
 Synonyms: *B. enteritidis* (Tank) of Peckham, 1923; Derby type of Savage and Bruce White, 1925; *Salmonella derby*, Warren and Scott, 1929–30; Typus-Derby of Kauffmann, 1931.
11. **Salmonella abortus-equi** (Good Corbett, Meyer and Boerner) *comb. nov.*
 Antigenic structure IV: enx: —.
 Isolated by Theobald Smith in 1893, and by Good, 1912, and Meyer and Boerner from cases of equine abortion.
 Synonyms: *Bacillus abortivus equinus*, Good and Corbett, 1913; *Bacterium abortus equi*, Meyer and Boerner, 1913;
 This name may be regarded as an orthographic variant of the foregoing.
Bacillus abortivo-equinus, Good and Corbett, 1916; *Salmonella abortivo-equinus* (Good) Bergey *et al.*, 1930; Typus-Abortus equi of Kauffmann, 1931.
12. **Salmonella abortus-ovis** (Schermer and Ehrlich) *comb. nov.*
 Antigenic structure IV: c: 1, 4, 6.
 Isolated by Schermer and Ehrlich from cases of ovine abortion.
 Synonyms: *Bac. paratyphi abortus ovis*, Schermer and Ehrlich, 1921; *Bacterium abortus ovis*, Lovell, 1931; Typus-Abortus ovis of Kauffmann, 1931.
13. **Salmonella brandenburg** Kauffmann and Mitsui *comb. nov.*
 Antigenic structure IV: enlv: —.
 Isolated in 1929 from a case of acute gastro-enteritis by Kauffmann and Mitsui.
 Synonym: Typus-Brandenburg of Kauffmann and Mitsui, 1930, and of Kauffmann, 1931.

GROUP C

14. *Salmonella paratyphi-C* (Andrewes and Neave) *comb. nov.*

Antigenic structure VI, VII: c: 1, 4, 5.

Synonyms: *B. paratyphosus* β_5 of Weil, 1917; *Bac. Erzinjan*, Neukirch, 1918;

Includes strains of *S. paratyphi-C*, *S. enteritidis* and *S. enteritidis* var. *moscow*. Homonym.

“Gaertner-paratyphoid group” organism of MacAdam, 1919; “Para-C” of Mackie and Bowen, 1919; Paratyphoid C bacillus of Hirschfeld, 1919; *B. paratyphosus B Hirschfeld* type of Schütze, 1920; Paratyphoid C bacillus of Dudgeon and Urquart, 1920; *B. paratyphosus C*, Andrewes and Neave, 1921;

B. paratyphosus C may be regarded as an orthographic variant of *B. paratyphi-C*.

Paratyphus C₂ of Weigmann, 1925, 1925 *a*; Paratyphus N₁ of Iwaschenzoff, 1926; *Salmonella hirschfeldii*, Weldin, 1927; Typus-Orient of Kauffmann, 1931.

15. *Salmonella cholerae-suis* (Smith) *comb. nov.*

Antigenic structure VI, VII: c: 1, 3, 4, 5.

American Hog-cholera organism. Isolated by Salmon and Smith in 1885.

Synonyms: Bacillus of Hog-cholera of Salmon and Smith, 1885; *B. cholerae suis*, Smith, 1893, 1894;

Smith and Reagh, 1903, refer to a strain of “*B. cholerae-suis*,” isolated in 1898, as a typical strain of the “Hog-cholera bacillus” corresponding to the senior author’s original description. This strain was re-examined by Jordan, 1917, and by Jordan and Victorson, 1917, and found to be typical and H₂S negative.

B. cholerae suum, Migula, 1895 (Engler and Prantl, 1895); *B. suipestifer*, Kruse, 1896 (Flügge, 1896);

B. cholerae suum, Migula, and *B. suipestifer*, Kruse: The descriptions of Migula and Kruse apply equally to the American and European types of Hog-cholera bacteria, which they did not differentiate. It is stated by Haupt, 1932 (Weichardt, 1932) “der von Salmon und Smith erstmalig beschriebene Erreger hat demnach das Epitheton speciale ‘Suipestifer’ von Kruse regelrecht erhalten,” but Preisz, 1898, on the other hand, states that *B. suipestifer* Kruse is “der Erreger der deutschen Schweineseuche oder Schweineseptikämie.”

B. salmoni, Chester, 1901; *B. cholerae suis*, Jordan, 1917; *B. paratyphosus B. Arkansas* type of Schütze, 1920; Group I suipestifer of Andrewes and Neave, 1921;

This group also included *B. typhi-suis* of Glasser, 1909.

Typus-Suipestifer Amerika of Kauffmann, 1931.

Presents cultural differences from *S. typhi-suis*.

16. *Salmonella cholerae-suis* (Smith) var. *kunzendorf* [Pfeiler] (Kauffmann).

Antigenic structure VI, VII: —: 1, 3, 4, 5.

European Hog-cholera organism.

Synonyms: *B. cholerae suum*, Migula, 1895 (Engler and Prantl, 1895); *B. suipestifer* Kruse, 1896 (Flügge, 1896);

B. cholerae suum, Migula, and *B. suipestifer* Kruse. The descriptions of Migula and Kruse applied equally to the European and American types of Hog-cholera bacteria, which they

did not differentiate. It is stated by Haupt, 1932 (Ref. Weichardt, 1932) "der von Salmon und Smith erstmalig beschriebene Erreger hat demnach das Epitheton speciale 'Suipestifer' von Kruse regelrecht erhalten," but Preisz, 1898, on the other hand, states that *B. suipestifer* Kruse is "der Erreger der deutschen Schweineseuche oder Schweineseptikämie."

"Paratyphus C" *Bacillus* (so-called) of Heimann, 1912;

Isolated from food-poisoning epidemic at Hildesheim in 1911, but no "Einheitlichkeit" was claimed for the strains examined. Andrewes and Neave, 1921, state that the authors did not employ distinguishing fermentation tests, did not test against a "suipestifer" serum, and that it is impossible to be sure of the nature of the organisms. Bruce White, 1926, however, identified some of the strains isolated as being of the European Hog-cholera type.

Paratyphosus β_1 of Weil and Saxl, 1917; Typus-Suipestifer Kunzendorf, Pfeiler, 1917 (Pfeiler, 1920);

Pfeiler here speaks of "Typus Suipestifer Kunzendorf, wie er mit Rücksicht auf das gehäufte Vorkommen in diesem Bestande von uns genannt worden ist." A culture, of origin 1913 or previously, received from Pfeiler himself and labelled "Suipestifer Kunzendorf-Bromberg," was examined by Kauffmann, 1929 *a*, and proved to be of the European Hog-cholera type.

B. paratyphosus B. G. type of Schütze, 1920;

Isolated from mesenteric gland of a monkey dying during a dietetic experiment, 1917.

B. paratyphosus C., Dudgeon and Urquart, 1920; Group II Suipestifer of Andrewes and Neave, 1921;

This group also included *B. suipestifer Voldagsen* of Dammann and Stedefeder, 1910.

Group V of Hecht-Johansen, 1923; *B. paratyphosus* C., Wordley, 1923; *Salmonella suipestifer* (European variety) Schütze, 1930; Typus-Suipestifer Kunzendorf of Kauffmann, 1931.

Presents cultural differences from *S. typhi-suis* var. *voldagsen* and *S. thompson* var. *berlin*.

17. *Salmonella typhi-suis* (Glässer) *comb. nov.*

Antigenic structure VI, VII: c: 1, 3, 4, 5.

Synonyms: *Bac. typhi-suis*, Glässer, 1909; *B. glässer*, Neukirch, 1918; Group I Suipestifer of Andrewes and Neave, 1921;

This group also included the American hog-cholera organism.

Typus-Glässer of Kauffmann, 1931; "Ferkeltyphus" organism of the German literature.

Presents cultural differences from *S. cholerae-suis*.

18. *Salmonella typhi-suis* (Glässer) var. *voldagsen* (Dammann and Stedefeder).

Antigenic structure VI, VII: —: 1, 3, 4, 5.

Described as cause of "Ferkeltyphus" (Dammann and Stedefeder, 1910).

Synonyms: *B. suipestifer Voldagsen*, Dammann and Stedefeder, 1910;

The "Paratyphus B. Bazillus vom Typus Voldagsen" of Bernhardt, 1913, has been identified with Pfeiler's organism by Savage and Bruce White, 1925, while Pieper's (Pieper, 1926) "Voldagsen" organism belongs to the "Newport" type (Kauffmann, 1931).

Bac. voldagsen, Neukirch, 1918; Group II Suipestifer of Andrewes and Neave, 1921;

This group also included *Bac. suipestifer Kunzendorf* of Pfeiler, 1920.

Typus-Voldagsen of Kauffmann, 1931.

Presents cultural differences from *S. cholerae-suis* var. *kunzendorf* and *S. thompson* var. *berlin*.

19. **Salmonella thompson** Scott *comb. nov.*

Antigenic structure VI, VII: k: 1, 3, 4, 5.

Isolated by Scott from cases of acute gastro-enteritis.

Synonyms: "Thompson" type of Salmonella of Scott, 1926; Typus-Thompson-Berlin of Kauffmann, 1931.

20. **Salmonella thompson** Scott var. *berlin* (Kauffmann).

Antigenic structure VI, VII: —: 1, 3, 4, 5.

Isolated in 1928 by Kauffmann from cases of acute gastro-enteritis, Berlin.

Synonyms: Typus-Berlin of Kauffmann, 1929, 1929 *a*; Typus C. Berlin of Boecker and Kauffmann, 1930; Typus-Thompson-Berlin of Kauffmann and Mitsui, 1930 *a*, and of Kauffmann, 1931.

Presents cultural differences from *S. cholerae-suis* var. *kunzendorf* and *S. typhi-suis* var. *voldagsen*.

21. **Salmonella virchow** Kauffmann *comb. nov.*

Antigenic structure VI, VII: r: 1, 2, 3.

Isolated in 1927 by Kauffmann from a case of acute gastro-enteritis in Berlin.

Synonym: Typus-Virchow of Kauffmann, 1930, 1931.

22. **Salmonella oranienburg** Kauffmann *comb. nov.*

Antigenic structure VI, VII: mt: —.

Isolated in 1929 by Kauffmann from cases of acute gastro-enteritis.

Synonym: Typus-Oranienburg of Kauffmann, 1930, 1931.

23. **Salmonella potsdam** Kauffmann and Mitsui *comb. nov.*

Antigenic structure VI, VII: enlv: —.

Isolated by Seligmann and Clauberg. Acute gastro-enteritis. Typed by Kauffmann and Mitsui.

Synonym: Typus-Potsdam of Kauffmann and Mitsui, 1930, and of Kauffmann, 1931.

24. **Salmonella bareilly** Bridges and Scott *comb. nov.*

Antigenic structure VI, VII: y: 1, 3, 4, 5.

Isolated by Dabholkar in 1928 and by Bodman in 1929 from cases of mild pyrexia, Bareilly, India. Typed by Bridges and Scott.

Synonym: Salmonella, Type "Bareilly," Bridges and Scott, 1931.

25. **Salmonella newport** Schütze.

Antigenic structure VI, VIII: eh: 1, 2, 3.

Food-poisoning in man, Newport, England, 1915.

Separated by Schütze in 1915 from so-called "Aertrycke" type of food-poisoning organism.

Synonyms: Paratyphus β_2 of Weil and Saxl, 1917; *B. paratyphosus* *B. Newport* type of Schütze, 1920; Paratyphus-Newport Bacillus of Kauffmann, 1929; *Salmonella newport*, Schütze, 1930; Typus-Newport of Kauffmann, 1931.

26. ***Salmonella newport*** Schütze var. *puerto-rico* (Kauffmann).
 Antigenic structure VI, VIII: —: 1, 2, 3.
 Isolated by Jordan in Puerto Rico in 1930 from patients suffering from acute attacks of diarrhoea (Jordan, 1934). Typed and named by Kauffmann, 1934.
27. ***Salmonella newport*** Schütze var. *kottbus* (Kauffmann).
 Antigenic structure VI, VIII: eh: 1, 3, 4, 5.
 Isolated by Kauffmann in 1928. Acute gastro-enteritis, Kottbus. Typed and named by Kauffmann, 1934.
28. ***Salmonella bovis-morbificans*** (Basenau) *comb. nov.*
 Antigenic structure VI, VIII: r: 1, 3, 4, 5.
 Isolated by Basenau from cattle.
 Synonyms: *Bacillus bovis morbificans* Basenau, 1894; *B. morbificans bovis* (Basenau) of Sladden and Scott, 1927;
 This name may be regarded as an orthographic variant of the foregoing.
 Typus-Morbificans bovis of Kauffmann and Mitsui, 1930 *a*, and of Kauffmann, 1931; *Flavobacterium morbificans*, Bergey *et al.*, 1930.
29. ***Salmonella muenchen*** (Mandelbaum) *comb. nov.*
 Antigenic structure VI, VIII: d: 1, 2.
 Isolated in 1931 by Mandelbaum, München.
 Synonyms: Typus-München of Mandelbaum, 1932; Typus-München of Silberstein, 1932.

GROUP D.

30. ***Salmonella typhi*** (Schröter) Warren and Scott.
 Antigenic structure IX: d: —.
 Isolated from enteric fever cases by Gaffky.
 Synonyms: *Bacillus des Abdominal Typhus* of Eberth, 1880; *Typhus Bacillus* of Gaffky, 1884; *Bacillus typhosus*, Zopf, 1885;
 The specific name "*typhosus*" proposed by Zopf in 1885 is invalid as it was first used by Klebs, 1880, for a different organism.
Bacillus typhi, Schröter, 1886; *Bacillus typhi abdominalis*, Flügge, 1886; *Vibrio typhosus*, Trevisan, 1889; *Eberthella typhi*, Buchanan, 1918; *Eberthus typhosus*, Castellani and Chalmers, 1919; *Salmonella typhi*, Warren and Scott, 1929–30; Schütze, 1930; *Salmonella typhosus*, Bruce White, 1929–30; Typus-Typhus of Kauffmann, 1931.
31. ***Salmonella enteritidis*** (Gärtner) Castellani and Chalmers.
 Antigenic structure IX: gom: —.
 Originally isolated by Gärtner from food-poisoning at Frankenhausen in 1888 (Kolle and Wassermann, 1913).
 Synonyms: *Bacillus enteritidis*, Gärtner, 1888; *Salmonella enteritidis* (Gärtner) Castellani and Chalmers, 1919; Typus-Gärtner Jena of Kauffmann,

1930, 1931; *Salmonella enteritidis* (Gärtner) Ibrahim and Schütze, 1928, Warren and Scott, 1929–30, and Bruce White, 1929–30.

32. ***Salmonella enteritidis*** (Gärtner) Castellani and Chalmers var. *danysz* (Bahr).

Antigenic structure IX: gom: —.

Isolated by Danysz in 1900. The Ratin strain (Ratin-Gesellschaft, Copenhagen) was isolated from the urine of a sick child by Neumann in 1902.

Synonyms: Danysz type of Bahr, 1928, 1930, 1930 *a*; Typus-Gärtner Ratin of Kauffmann, 1931.

May be considered as a variety of Gärtner's organism on account of its negative action on Stern's glycerin (Kauffmann). See Kristensen and Bojlén, 1931.

33. ***Salmonella enteritidis*** (Gärtner) Castellani and Chalmers var. *dublin* (Bruce White, Warren and Scott).

Antigenic structure IX: gp: —.

Isolated by Jensen, 1891, from cases of 'Kalberuhr' but not differentiated from the colon bacillus. Included by Jensen, 1913, among the "paracoli bacilli" (lactose and saccharose negative members of the colon-typhoid group). The name *B. paracoli* itself appears to have been used first by Gwyn, 1898, for an undetermined paratyphoid organism. (Since identified with *S. paratyphi-A*.)

Synonyms: *B. enteritidis* of Pesch, 1926;

Not differentiated from Gärtner's organism.

Gärtner-Jensen type of Bahr, 1928, 1930, 1930 *a*; Dublin type of Bruce White, 1929–30; *Salmonella dublin*, Warren and Scott, 1929–30; *Salmonella dublin*, Smith and Scott, 1930; Typus-Kiel of Kauffmann, 1930; Typus-Dublin-Kiel of Kauffmann, 1931.

34. ***Salmonella enteritidis*** (Gärtner) Castellani and Chalmers var. *rostock* (Kauffmann).

Antigenic structure IX: gpu: —.

Original cultures were from Prof. Poppe of the Rostock Institute.

Synonyms: Poppe Type of Bahr, 1928, 1930, 1930 *a*; Typus-Gärtner Rostock of Kauffmann, 1930, 1931.

35. ***Salmonella enteritidis*** (Gärtner) Castellani and Chalmers var. *moscow* (Bruce White, Hicks, Warren and Scott).

Antigenic structure IX: goq: —.

Isolated from cases of "Paratyphoid" fever.

Synonyms: Paratyphus C₁ of Weigmann, 1925, 1925 *a*; Paratyphus N₂ of Iwaschenzoff, 1926; *Salmonella*, type Moscow of Bruce White and Hicks, 1929–30 (Hicks, 1929–30); *Salmonella moscow*, Warren and Scott, 1929–30; Typus-Gärtner Moskau of Kauffmann, 1930, 1931.

36. ***Salmonella sendai*** Bruce White *comb. nov.*

Antigenic structure IX: a: 1, 4, 5.

Isolated from cases of "paratyphoid" fever by Aoki of Sendai University, Japan.

Synonyms: "Atypical Paratyphosus A" bacillus of Aoki and Sakai, 1925; Sendai type of Bruce White, 1926; Typus-Sendai of Kauffmann, 1931.

37. ***Salmonella dar-es-salaam*** Schütze *ex* Brown, Duncan and Henry, *comb. nov.*

Antigenic structure IX: enlw: —.

Isolated by Butler in 1922 from case of pyrexia at Dar-es-Salaam, East Africa. Typed by Schütze.

Synonyms: Type-Dar-es-Salaam (Bruce White) of Brown, Duncan and Henry, 1926; Type-Dar-es-Salaam of Bruce White, 1926; Typus-Dar-es-Salaam of Kauffmann and Mitsui, 1930, and of Kauffmann, 1931.

38. ***Salmonella eastbourne*** Leslie and Shera.

Antigenic structure IX: eh: 1, 3, 4, 5.

Isolated from "paratyphoid" case at Eastbourne, England.

Typed and named by Leslie and Shera, 1931.

39. ***Salmonella panama*** Kauffmann.

Antigenic structure IX: lv: 1, 3, 4, 5.

Isolated by Jordan in 1931 from a food-poisoning outbreak that occurred in a group of American soldiers stationed at the Panama Canal Zone (Jordan, 1934). Typed and named by Kauffmann, 1934.

40. ***Salmonella gallinarum*** (Klein) Bergey *et al.*

Antigenic structure IX: —: —.

Isolated from fowls by Klein.

Synonyms: *Bacillus gallinarum*, Klein, 1889; *Bacillus sanguinarium*, Moore, 1895; *Bacterium gallinarum*, Migula, 1900; *Bacillus typhi gallinarum alcalifaciens*, Pfeiler and Rehse, 1913; *Eberthella sanguinaria*, Bergey *et al.*, 1923; *Salmonella gallinarum*, Bergey *et al.*, 1930.

Presents well-marked cultural differences from *S. pullorum*.

41. ***Salmonella pullorum*** (Rettger) Bergey *et al.*

Antigenic structure IX: —: —.

Organism described by Rettger, 1900, 1901, and by Rettger and Harvey, 1908, but not named. Isolated from chickens (White diarrhoea).

Synonyms: *Bacterium pullorum*, Rettger, 1909; *Salmonella pullora*, (Rettger) Bergey *et al.*, 1923; *Salmonella pullorum*, (Rettger) Bergey *et al.*, 1930; Typus-Pullorum of Kauffmann, 1931.

Presents well-marked cultural differences from *S. gallinarum*.

GROUP E.

42. ***Salmonella london*** Kauffmann *comb. nov.*

Antigenic structure X, III: lv: 1, 4, 6.

Isolated by Bruce White from dejecta of patient "L," Reading, England.

Synonyms: *Salmonella*, Type L, Bruce White, 1926; Typus-London of Kauffmann, 1930, 1931.

43. ***Salmonella anatum*** (Rettger and Scoville) Bergey *et al.*

Antigenic structure X, III: eh: 1, 4, 6.

Isolated by Rettger and Scoville from epizootic of "keel" in ducklings, U.S.A.

Synonyms: *Bacterium anatis*, Rettger and Scoville, 1919;

Invalid, as this name had been given by Cornil and Toupet, 1888, to a different organism. It was therefore changed by the authors to *Bact. anatum*.

Bacterium anatum, Rettger and Scoville, 1920;

On subsequent investigation some of Rettger and Scoville's strains were proved to be *S. typhi-murium*, but others were a new serological type of *Salmonella*.

Escherichia anata, Bergey *et al.*, 1923; *Salmonella anatum*, Bergey *et al.*, 1930.

44. ***Salmonella anatum*** (Rettger and Scoville) Bergey *et al.* var. *muenster* (Kauffmann and Silberstein).

Antigenic structure X, III: eh: 1, 4, 5.

Isolated by Besserer, Münster, from a case of acute gastro-enteritis. Typed and named by Kauffmann and Silberstein, 1934.

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