A NEW SALMONELLA TYPE POSSESSING A HITHERTO UNDESCRIBED NON-SPECIFIC ANTIGEN*

By PHILIP R. EDWARDS

Department of Animal Pathology, Kentucky Agricultural Experiment Station, Lexington, Kentucky, U.S.A.

In a previous publication the writer (1935) confirmed the conclusion reached by Kauffmann & Silberstein (1934) that the antigenic formula of *Salmonella anatum* was III X : *eh* : 1, 4, 6. The writer noted, however, that two cultures of *S. anatum*, namely strains C 1 and C 2 of Rettger & Scoville (1920), possessed a distinct somatic antigen in place of factor X. This antigen, which Kauffmann & Silberstein had noted in strain C 1 and attributed to roughness, was designated XII, the writer not being aware that Kauffmann (1935) had used XII for an antigen found in groups B, C and D of the Kauffmann-White schema. Kauffmann (1936) confirmed the writer's conclusion that this was a distinct somatic antigen and in the recent meetings of the Salmonella subcommittee of the International Society for Microbiology this antigen was assigned the symbol XV. The antigenic formula of strains C 1 and C 2 of Rettger and Scoville is, therefore, III XV : *eh* : 1, 4, 6. As it is customary to accord species recognition to strains having distinct somatic antigens, it is proposed to refer to these strains henceforward as the Newington type, since they were isolated by Dr L. F. Rettger from ducklings from Newington, Conn.

The recognition of factor XV as a distinct antigen and of the cultures in question as a distinct species is now doubly important since a new serological type having the same somatic antigens as the Newington type has been encountered. It is with this new species that the present paper is concerned. In March 1936, the writer received from Dr F. R. Beaudette a culture isolated from a baby chick, the origin of which was unknown. The culture was forwarded for identification. Since the organism was isolated at New Brunswick, N.J., it will henceforward be referred to as the New Brunswick type. On examination it was found to produce acid and gas from glucose, rhamnose, arabinose, xylose, trehalose, sorbitol, dulcitol and inositol. Sucrose and lactose were not attacked. Hydrogen sulphide was produced and the tartrate agar of Jordan & Harmon (1928) was promptly acidified.

The methods used in the examination of the serological characters of the organism were the same as those employed by Edwards (1935). Alcohol-

* The investigation reported in this paper is in connexion with a project of the Kentucky Agricultural Experiment Station and is published by permission of the Director.

treated suspensions of the bacillus were agglutinated by serums derived from the Senftenberg, London and Newington types. Little or no agglutination occurred in serums of other types. Absorption of London serum with Senftenberg and absorption of Senftenberg serum with London removed all somatic agglutinins for New Brunswick from these serums. The only somatic factor common to the three types is III. Absorption of Newington serum with Senftenberg or London left a pronounced residue of unabsorbed agglutinin for New Brunswick. Reciprocal absorption tests with Newington and New Brunswick revealed that their somatic antigens were identical. Thus the somatic factors of New Brunswick are III, XV.

Examination of the flocculating antigens revealed that the bacillus was a diphasic organism. Agglutinating serum prepared from the specific phase flocculated the specific phases of London and Panama in high dilution. Likewise serum prepared from the specific phase of Panama flocculated the specific phase of New Brunswick to the titre of the serum. Absorption tests resulted in a complete removal of specific agglutinins from New Brunswick serum by the specific phases of Panama and London. The New Brunswick type effected a total exhaustion of specific agglutinins from serum derived from the specific phase of Panama. The New Brunswick type, therefore, possesses specific factors *lv*.

While the determination of the somatic and specific antigens of the New Brunswick type offered no unusual difficulties, the group antigens were more complicated. Two other species of Salmonellas more or less closely related to New Brunswick, the group phases of which were unknown, were included in the study. These were *S. anatum* var. *nyborg* of Kristensen & Bojlen (1936) and the Bredeney type of Kauffmann (1936*a*). It may be said at the outset of the discussion that the non-specific antigens of New Brunswick, *S. anatum* var. *nyborg* and Bredeney are identical and any remark concerning the group phase of one of them applies equally well to the other. Serums were prepared from the non-specific phases of the three types. Each species was able to exhaust the serums of the other two of non-specific agglutinins. The pertinent facts concerning the non-specific phase of the New Brunswick type are included in Table I. It is apparent that New Brunswick contains a strongly developed non-specific antigen not present in *S. paratyphi* B, *S. typhi-murium*, Kunzendorf or London. That this reaction is not caused by a specific antigen is attested by the behaviour of the Nyborg type whose specific factors are not related to those of New Brunswick. We have here a new non-specific antigen to which the symbol 7 is assigned.

The New Brunswick type does not possess factors 3, 4, 5 or 6 of the Kauffmann-White schema. While it is true that absorption of Typhi-murium or New Brunswick serum with Paratyphi B left unabsorbed a slight residue of agglutinin acting upon Typhi-murium and New Brunswick, this does not signify the presence of factor 3 in New Brunswick. It is a minor factor common to these two types. Proof that New Brunswick does not contain factor 3 is

the lack of agglutination of Kunzendorf by New Brunswick serum after absorption with Paratyphi B and the pronounced agglutination of Kunzendorf by Typhi-murium serum after absorption with New Brunswick.

That other minor factors are present in the non-specific phases of the organisms is also apparent. There is a weakly developed antigen in Typhi-murium, Paratyphi B and London that is not possessed by New Brunswick. Likewise there is a poorly defined antigen common to Kunzendorf, Paratyphi B and New Brunswick that is not present in London.

Table I. *Non-specific antigens*

Antigens	Serums: New Brunswick non-specific	New Brunswick non-specific absorbed by Paratyphi B non-specific	New Brunswick non-specific absorbed by Typhi-murium non-specific	New Brunswick non-specific absorbed by Kunzendorf	New Brunswick non-specific absorbed by London non-specific	Typhi-murium non-specific absorbed by Paratyphi B non-specific	Typhi-murium non-specific absorbed by New Brunswick non-specific	Typhi-murium non-specific absorbed by Kunzendorf	Paratyphi B non-specific absorbed by New Brunswick non-specific	Kunzendorf absorbed by New Brunswick non-specific	Kunzendorf absorbed by Paratyphi B non-specific	Kunzendorf absorbed by London non-specific
New Brunswick non-specific	20,000	10,000	10,000	10,000	10,000	500	0	2,000	0	0	0	200
Nyborg non-specific	20,000	10,000	10,000	10,000	10,000	500	0	2,000	0	0	0	200
Paratyphi B non-specific	10,000	0	0	5,000	5,000	0	5,000	5,000	2,000	0	0	500
Typhi-murium non-specific	5,000	100	0	2,000	5,000	5,000	10,000	10,000	1,000	1,000	1,000	1,000
Kunzendorf	5,000	0	0	0	200	1,000	2,000	0	200	10,000	10,000	10,000
London non-specific	2,000	0	0	0	0	0	200	0	200	1,000	1,000	0

The minor antigens mentioned in the foregoing paragraph are evidenced by the occurrence of flocculation only in low dilutions of the serums. Even in the lowest dilution the degree of agglutination was slight and appeared only after the tests had been incubated for some time. Unlike the major factors, they were not apparent after a few minutes' incubation of the tests and they probably are not of sufficient magnitude to be represented in a schematic presentation of the antigens of the organisms involved.

Of entirely different significance is the obvious division of factor 2 into two parts by the tests. It is easily perceived that New Brunswick possesses a portion of factor 2 by its agglutination with Typhi-murium serum that has been absorbed with Kunzendorf. Likewise Typhi-murium and Paratyphi B are rapidly and strongly flocculated by New Brunswick serum that has been absorbed with Kunzendorf. That it does not possess the whole of factor 2 is evidenced by its failure to clear Typhi-murium serum of agglutinins for Paratyphi B and Paratyphi B serum of agglutinins for Typhi-murium. These results can be explained only by assuming that the antigenic fraction previously designated as 2 is divisible into two parts, one possessed by New Brunswick and both present in Paratyphi B and Typhi-murium. The tests

having a critical bearing on the non-specific antigens have been repeated many times using a variety of serums and cultures. Invariably the results have been the same and they cannot be reconciled with the group antigens as represented in the Kauffmann-White schema.

The group phases of the New Brunswick and Nyborg types will be designated simply as 1, 7+. A revision of the group factors of the Kauffmann-White schema is necessary before a correct formula for these types can be evolved. Kauffmann (1936) is now working on this revision and it is in order to avoid confusion and duplication of factors that only the simplified non-specific formula is given. The antigenic formulae of the organisms of the London-Anatum group are as follows:

London	III X : *lv* : 1, 4, 6.
Anatum	III X : *eh* : 1, 4, 6.
Anatum var. muenster	III X : *eh* : 1, 4, 5.
Anatum var. nyborg	III X : *eh* : 1, 7+.
Newington	III XV : *eh* : 1, 4, 6.
New Brunswick	III XV : *lv* : 1, 7+.

SUMMARY

The designation, Newington, is proposed for those cultures of *S. anatum* having the antigenic formula III XV : *eh* : 1, 4, 6. A new type, New Brunswick, is described which is represented by the formula III XV : *lv* : 1, 7+. Attention is called to the inadequacy of the symbols currently employed in the representation of the non-specific antigens to express correctly the non-specific phases of the Nyborg and New Brunswick types.

ACKNOWLEDGEMENTS. The writer takes this opportunity to acknowledge his indebtedness to Dr F. R. Beaudette for forwarding the culture of the New Brunswick type and to Dr F. Kauffmann and Dr H. Schütze for helpful advice concerning the designation of the new non-specific antigen.

REFERENCES

EDWARDS, P. R. (1935). *J. Bact.* **30**, 269.
JORDAN, E. O. & HARMON, P. (1928). *J. Infect. Dis.* **42**, 238.
KAUFFMANN, F. (1935). *Z. Hyg.* **116**, 617.
—— (1936). Personal communication.
—— (1936*a*). *Z. Hyg.* **117**, 778.
KAUFFMANN, F. & SILBERSTEIN, W. (1934). *Zbl. f. Bakt.*, Abt. I, Orig. **132**, 431.
KRISTENSEN, M. & BOJLEN, K. (1936). *Ibid.* **136**, 294.
RETTGER, L. F. & SCOVILLE M. (1920). *J. Infect. Dis.* **26**, 217.

(*MS. received for publication* 22. I. 1937.—Ed.)