TWO NEW *SALMONELLA* TYPES ISOLATED FROM FOWLS[1]

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Among a group of *Salmonella* cultures received from Dr B. S. Pomeroy were three cultures which were identical with none of the previously described species. Further study revealed that two of the cultures were identical, so that the three cultures represent two serological types. The present paper is a characterization of these two types.

A. *Salmonella minnesota*

The one culture by which this species is represented was isolated by Dr Pomeroy in 1936 from a 3 weeks' old poult. Since the poult from which the organism was isolated came from a turkey farm in Minnesota, the organism is referred to as *S. minnesota*. The organism is a motile rod which possesses the morphological and tinctorial characteristics generally attributed to members of the genus. It produces acid and gas from glucose, arabinose, trehalose, rhamnose, dulcitol, sorbitol and inositol. Lactose and sucrose are not fermented. The organism does not produce indole and gelatin is not liquefied. Hydrogen sulphide is formed in peptone broth and the tartrate agar of Jordan & Harmon (1928) is rapidly acidified.

An agglutinating serum prepared from *S. minnesota* contained no agglutinins for somatic antigens I–XX of the Kauffmann-White schema. Likewise alcohol-treated suspensions of *S. minnesota* were not agglutinated by any *Salmonella* antiserums in our possession. It appears, therefore, that the somatic antigen of *S. minnesota* is unlike any of those previously described and to it is assigned the symbol XXI.[2]

Examination of the flagellar antigen of *S. minnesota* revealed that no flocculation occurred in the presence of non-specific serums and that antiserum derived from it did not agglutinate the non-specific phases of diphasic *Salmonella* species. *S. minnesota* was flocculated rapidly and in high dilution by *S. paratyphi B* and *S. abortus equi* serums. It reacted to a lesser extent with *S. newport* and *S. anatum* serums. *S. minnesota* antiserum produced floccula-

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tion in all antigens containing factors **b** or **e**. Agglutination was much stronger in antigens containing factors **en** than in those containing **eh**.

Upon plating, the culture exhibited alpha-beta phase variation. Certain colonies were agglutinated by specific *S. paratyphi B* antiserum, while others were agglutinated by *S. abortus equi* antiserum. The pertinent fact concerning the reactions of the two phases are given in Table I. It is evident that the

Table I. *Floccular antigens of* S. minnesota

Antigens	Antiserums						
	S. minnesota	*S. paratyphi* B specific	*S. abortus equi*	*S. minnesota* absorbed by *S. paratyphi* B specific and *S. abortus equi*	*S. minnesota* absorbed by *S. abortus bovis*	*S. abortus equi* absorbed by *S. minnesota*-beta	*S. paratyphi* B specific absorbed by *S. minnesota*-alpha
S. minnesota-alpha	10,000	10,000	<200	200	2000	<200	<200
S. minnesota-beta	20,000	400	5000	<200	1000	<200	<200
S. paratyphi B specific	10,000	10,000	<200	<200	1000		400
S. abortus equi	20,000	<200	5000	<200	1000	<200	
S. abortus bovis-alpha					<200		
S. abortus bovis-beta					<200		

alpha phase of *S. minnesota* is closely related to the specific factor **b** of *S. paratyphi B*. The beta phase of *S. minnesota* is apparently identical with the factors **enx** of *S. abortus equi* since each removes agglutinins for the other in reciprocal absorption tests. The results obtained with the alpha phase of *S. minnesota* and the specific factor of *S. paratyphi B* are more complicated. Neither of these antigens effects a complete removal of agglutinins for the other, although only traces of agglutinins remain after absorption. The alpha phase of *S. minnesota* and the specific factor of *S. paratyphi B* have a common antigen which is not present in the alpha phase of *S. abortus bovis*. These results indicate that the factor **b** of the Kauffmann-White classification is somewhat complex as are the factors **d** (Henning, 1937; Kauffmann, 1937) and **g** (Kauffmann, 1937).

The results outlined above indicate that the antigenic formula of *S. minnesota* is XXI: **b ⇋ enx**. This adds another to the list of types having the specific factors **b ⇋ enx.** At present the following species are known to possess these antigens:

S. abortus bovis	I IV:	**b ⇋ enx** (Bernard, 1935).
S. hvittingfoss	XVI:	**b ⇋ enx** (Tesdal, 1936).
S. minnesota	XXI:	**b ⇋ enx.**

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B. *Salmonella worthington*

The two representatives of this type were isolated by Dr Pomeroy in 1937, one from a young turkey, the other from a chick. No history of the flock of which the chick was a member is available. The poult came from a farm on which turkeys from three different hatcheries were being reared. The poult, from which the organism under discussion was isolated, was purchased from a hatchery at Worthington, Minnesota. Therefore the organism is referred to as *S. worthington*. It is noteworthy that the poults from the two remaining hatcheries also were infected with paratyphoid bacilli. These organisms were identified as *S. derby*, *S. anatum* and *S. bareilly*.

Both cultures of *S. worthington* are motile rods which conform to the description of the genus *Salmonella*. The organisms produce acid and gas from glucose, arabinose, trehalose, rhamnose, dulcitol, sorbitol and inositol. Lactose and sucrose are not attacked. Indole is not produced and gelatin is not liquefied. Hydrogen sulphide is formed and tartrate agar is acidified.

On serological examination it was found that alcohol-treated suspensions of *S. worthington* were strongly agglutinated by *S. poona* antiserum. Weaker agglutination occurred in *S. paratyphi A*, *S. senftenberg* and *S. bredeney* antiserums. An agglutinating serum derived from *S. worthington* agglutinated an alcohol-treated suspension of *S. poona* in high dilution and similarly prepared suspensions of *S. paratyphi A*, *S. senftenberg* and *S. bredeney* in lower dilutions. By appropriate absorption tests it was demonstrated that the cross-agglutination between *S. worthington* and *S. paratyphi A*, *S. senftenberg* and *S. bredeney* is due to a minor somatic antigen not present in the somatic complex of *S. poona*. This is antigen I of the Kauffmann-White classification. It was further demonstrated that while *S. poona* and *S. worthington* share a major somatic antigen, each possesses an individual factor not found in the other. Bridges & Scott (1935) expressed the entire somatic complex of *S. poona* as XIII, since none of the then known types displayed closely related somatic antigens. It is now apparent that antigen XIII is more or less complex and cannot be expressed completely by one symbol. Using the next two available symbols, it is proposed to designate the somatic antigens of *S. poona* as XIII XXII and of *S. worthington* as I XIII XXIII. Kauffmann (1937*a*) called attention to the relation existing between the somatic antigens of *S. poona* and the Holstein type of Roelcke (1936). The somatic antigens of the Holstein type are also related to those of *S. worthington* but are identical neither with those of *S. worthington* nor of *S. poona*. Since, due to its fermentation of salicin and its production of indole there is some doubt as to whether the Holstein type is a member of the genus *Salmonella*, no factors are assigned it.

Study of the flagellar antigens demonstrated that *S. worthington* possesses no non-specific phase. It was flocculated by serums containing agglutinins for the factors **l** and **z**. When the culture was plated it exhibited alpha-beta phase variation. The reactions of the flagellar antigens of *S. worthington* are given in

Table II. *Floccular antigens of* S. worthington

Antigens	Antiserums										
	S. worthington-alpha	*S. worthington*-beta	*S. poona* specific	*S. dar-es-salaam*-alpha	*S. panama* specific	*S. worthington*-alpha absorbed by *S. dar-es-salaam*-alpha and *S. poona* specific	*S. dar-es-salaam*-alpha absorbed by *S. worthington*-alpha	*S. dar-es-salaam*-alpha absorbed by *S. brandenburg*-alpha	*S. panama* specific absorbed by *S. dar-es-salaam*-alpha	*S. worthington*-beta absorbed by *S. poona* specific and *S. dar-es-salaam*-alpha	*S. poona* specific absorbed by *S. worthington*-beta
S. worthington-alpha	10,000	2,000	2,000	20,000	10,000	<200	<200	5000	<200	<200	200
S. worthington-beta	2,000	20,000	20,000	1,000	500	<200				1000	<200
S. dar-es-salaam-alpha	10,000	200	<200	20,000	10,000	<200	<200	5000	<200	<200	
S. brandenburg-alpha	10,000	200	<200	20,000	10,000	<200		<200	2000		
S. panama specific	10,000	200		20,000	10,000	<200		<200	5000	<200	
S. poona specific	2,000	20,000	20,000			<200				<200	200

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Table II. The alpha phase was agglutinated to the titre of serums derived from the specific phase of *S. panama* and from the alpha phase of *S. dar-es-salaam*. Likewise serum derived from the alpha phase of *S. worthington* agglutinated the alpha phase of *S. dar-es-salaam* and the specific phase of *S. panama* to titre. Reciprocal absorption tests established the identity of the alpha phase of *S. dar-es-salaam* and of *S. worthington*.

The beta phase of *S. worthington* was flocculated to the titre of *S. poona* specific antiserum. Likewise, antiserum prepared from the beta phase of *S. worthington* agglutinated the specific phase of *S. poona* in high dilution. Reciprocal absorptions revealed that while *S. worthington* was capable of exhausting practically all the agglutinins from *S. poona* antiserum, absorption of *S. worthington* antiserum with *S. poona* left a considerable residue of agglutinin acting on the beta phase of *S. worthington*.

It is obvious that the alpha phase of *S. worthington* contains the antigens **lw**, since it is absorptively identical with the alpha phase of *S. dar-es-salaam*. The beta phase of *S. worthington* is very closely related to the specific phase of *S. poona*. Inasmuch as they are not identical it is proposed to represent the beta phase of *S. worthington* as **z**.... The antigenic formulae of *S. worthington* and the species to which it is most closely related are:

S. poona—XIII XXII: **z**: 1, 6 (Bridges & Scott, 1935).

S. worthington—I XIII XXIII: **lw** ⇋ **z**....

S. dar-es-salaam—IX XII: **lw** ⇋ **en** (White, 1926; Kauffmann & Mitsui, 1930).

Summary

Two new *Salmonella* types are described. *S. minnesota* was isolated from a turkey. Its antigenic formula is XXI: **b** ⇋ **enx**. *S. worthington* was found both in a chicken and in a turkey. Its antigenic formula is I XIII XXIII: **lw** ⇋ **z**.... Transfers of each type have been deposited in the National Collection of Type Cultures of Great Britain and in the American Type Culture Collection.

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