THE SIGNIFICANCE OF M AND T ANTIGENS IN THE CROSS REACTIONS BETWEEN CERTAIN TYPES OF GROUP A HEMOLYTIC STREPTOCOCCI*

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Previous study of the matt variants of group A hemolytic streptococci and their degraded glossy derivatives has shown that these microorganisms contain two qualitatively different type-specific antigens, both of which are present in the matt variant, but only one in the glossy (1). Antibody to the type-specific protein, M, found in matt variants, appears responsible for the M precipitin reaction, for type-specific protection, and for part of the type-specific agglutination of matt variants. Antibody to the T substance, which is the recently recognized part of the antigenic complex found to be present in both matt and glossy variants, seems to be solely responsible for type-specific agglutination of the glossy form and to play the chief rôle in type-specific agglutination of the matt form. This T antibody is apparently not involved in protection. Whether the M and T substances occur as separate chemical entities or in conjugation is not as yet determined.

In members of the serological types so far studied, *viz.* types 1, 3, 6, and 14, the M antigen found in the matt variant and the T antigen found in both matt and glossy variants have always been characteristic of a single type. For example, type 1 matt strains always contained M and T substances characteristic of type 1, and type 1 glossy variants contained type 1 T antigen alone. None of these strains had an M substance characteristic of one type and a T substance characteristic of some other type. Such an anomaly has, however, been observed in the widely used strain, C203. The following experiments show that this strain has both type-specific antigens, M and T, that are present in type 3 matt strains, and, in addition, the T antigen of type 1. It does not, however, possess the type 1 M antigen. On the basis of this analysis of the antigens in strain C203,

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it is easy to account for the reactions of this strain in both type 1 and type 3 antisera.

EXPERIMENTAL

Strains.—In the present experiments, strain C203 was compared with the type 1 and 3 strains of hemolytic streptococcus employed in the experiments described elsewhere (1). This strain, isolated by Dr. Dochez about 1921, from a patient with scarlet fever, was obtained by us from Dr. M. B. Kirkbride in 1927 in mouse virulent form.

Strain J131, type 1, recovered from a child with otitis media in March, 1933, was a typical matt avirulent strain having originally an M.L.D. of 0.1 cc. for mice.

Strain P279, type 3, was a matt virulent strain, M.L.D. for mice 10^{-6} to 10^{-8} cc., obtained in 1928, from Dr. S. F. Jones, Princeton, New Jersey, from an epidemic of scarlet fever.

Methods.—The methods were the same as those described elsewhere (1).

Type-Specific Antigens Present in Strain C203. Reactions of This Strain in Type 1 Antisera

The presence of type 1 agglutinogen in strain C203 was first demonstrated by Griffith, who therefore classified it by the slide agglutination technique as a member of type 1 (2). His finding was readily confirmed in this laboratory by both slide and test tube agglutinations and by absorption of agglutinins from type 1 serum with bacteria of strain C203. At the same time it was found that none of the reactions characteristic of the type 1 M substance could be obtained with this strain.

Reciprocal Absorption Experiments

Reciprocal absorption experiments were performed by absorbing, with matt and glossy variants of the three strains concerned, the antisera prepared against the following strains: the matt variant of strain C203, the matt variants of types 1 and 3, and the glossy variant of type 1. Agglutination reactions, M precipitin reactions, and passive protection tests in mice were then done with nearly all combinations of these strains and antisera; the results are given in Tables I to VI.

The agglutination reactions in Table I, section A, show that strain C203 matt, as well as type 1 matt and glossy strains, agglutinated in unabsorbed type 1 matt antiserum and type 1 glossy antiserum. Furthermore, absorption with strain C203 matt removed all agglutinins from these antisera just as well as did absorption with the homologous type 1 matt and glossy strains. Type 3 matt and glossy strains, on the contrary, neither agglutinated in these antisera (last two columns of section A) nor absorbed the agglutinins for the type 1 strains or for strain C203 (section A, last two rows of the experiment with each serum). From these agglutination experiments, the obvious conclusion was that strain C203 was closely re-

lated to type 1 in containing the type 1 antigen, T, which is the only agglutinogen of type 1, and that type 3 was unrelated to strain C203 and type 1 in this respect.

TABLE I

Relationship of Strain C203 to Types 1 and 3

Immunological Reactions in Type 1 Antisera

Type 1 antisera	*Section A* Agglutinations with culture of					*Section B* Precipitin reactions with M extract of					**Section C* Passive protection in mice against infection with cultures		
	Type 1 matt	Type 1 glossy	C203 matt	Type 3 matt	Type 3 glossy	Type 1 matt	Type 1 glossy	C203 matt	Type 3 matt	Type 3 glossy	Type 1 matt	C203 matt	Type 3 matt
Type 1 Matt Antiserum													
Not absorbed	++++	++++	++++	−	−	++++	−	+	±	−	S	D	D
Absorbed with bacteria of													
Type 1 matt	−	−	−	−	−	−	−	−	−	−	D		
Type 1 glossy	−	−	−	−	−	++++	−	−	−	−	S		
C203 matt	−	−	−	−	−	++++	−	−	−	−	S		
Type 3 matt	++++	++++	++++	−	−	++++	−	−	−	−	S		
Type 3 glossy	++++	++++	++++	−	−	++++	−	−	−	−	S		
Type 1 Glossy Antiserum													
Not absorbed	++++	++++	++++	−	−	−	−	−	−	−	D (usually)		
Absorbed with bacteria of													
Type 1 matt	−	−	−	−	−	−	−	−	−				
Type 1 glossy	−	−	−	−	−	−	−	−	−				
C203 matt	−	−	−	−	−	−	−	−	−				
Type 3 matt	++++	++++	++++	−	−	−	−	−	−				
Type 3 glossy	++++	++++	++++	−	−								

++++ to − indicate estimates of the agglutination and precipitin reactions, which were performed in the same manner and with the same series of dilutions as those shown in Tables I to IV of the preceding paper (1).

S indicates that the serum tested afforded satisfactory protection.

D indicates no protection.

* These protection experiments are given in detail in Table I, preceding paper, and in Tables V and VI of the present paper.

That strain C203 is not, however, identical with type 1 is evident from the precipitin reactions shown in section B. The type 1 matt strain is the only one of this group of strains from which there could be obtained an M extract giving a type-specific precipitin reaction with type 1 matt antiserum. Similarly, the type 1 matt strain was the only one which absorbed the type-specific precipitin from this serum. The slight reactions of M

extract from strains C203 matt and type 3 matt in unabsorbed type 1 matt antiserum were non-type-specific since they were removed by absorption with heterologous as well as homologous strains. The type 1 glossy antiserum gave no M precipitin reactions. The results of these precipitin absorption experiments with type 1 antisera and the strains under investigation are consistent in showing that strain C203 did not contain the M antigen characteristic of type 1, although the agglutination reactions of the same absorbed and unabsorbed sera indicated that this strain contained the T antigen of type 1.

The passive protection tests in mice with these sera parallelled the M precipitin reactions (section C). Unabsorbed type 1 matt antiserum protected mice against infection with type 1 matt strains but not against infection with C203 matt or type 3 matt strains. In the same way, the type 1 matt strain was the only one which absorbed this protective antibody from the serum (section C, column 1). Full details of the protection tests summarized in Table I are given in other tables as noted.

Attempt to Absorb Type 1 Protective Antibodies with Strain C203.—The capacity of strain C203 to absorb the protective antibodies from type 1 matt antisera prepared against several different type 1 strains was investigated and confirmed the conclusion made from the results shown in Table I, that this strain did not contain type 1 M substance since it did not absorb type 1 M precipitin nor type 1 protective antibody.

Four different antisera, prepared with the type 1 matt strains indicated in Table II, and one strain C203 matt antiserum were absorbed, in the same experiment, with whole bacteria of strain C203 matt. These absorbed sera, together with unabsorbed control portions of serum, were used in passive protection tests in mice to determine whether the type 1 protective antibody was removed. In these experiments, from one to three dilutions of type 1 matt culture were used with varying dilutions of serum.

Table II shows that strain C203 matt did not absorb a significant amount of type 1 protective antibody from any of the four type 1 sera employed, although it absorbed completely the protective antibody from matt antiserum prepared with strain C203 matt. Other experiments showed that type 1 matt culture readily absorbed type 1 protective antibody under the same conditions. (Table I in the preceding paper, section C, Experiments I, V, VI).

Precipitin and agglutinin tests, not tabulated here, on all these sera absorbed with strain C203 matt showed that this strain did not absorb M precipitin from the four type 1 sera but completely absorbed anti-M from the C203 serum; it also absorbed completely the type-specific agglutinins (anti-T) from all five sera.

Precipitin and Protection Reactions of Strain C203 Matt with Type 3 and Strain C203 Matt Antisera.—Precipitin tests with M extract from

TABLE II

Relationship of Strain C203 to Type 1

Passive Protection Tests in Mice with Sera Absorbed with Strain C203 Matt

Infecting strain for protection test		Antiserum			0.5 cc. of serum dilution									
		Type	Immunizing strain	Treatment of serum	1:2	1:4	1:8	1:16	1:32	1:64	1:128	1:256	1:512	1:1024
	cc.													
Type 1 matt*	10^{-2}	1	Type 1 matt	Not absorbed		D1	S	D1	D1	D1	D1			
	10^{-2}			Absorbed with C203 matt		D1	D7	D1	D1	D1	D5			
	10^{-3}			Not absorbed		S	S	S	D1	S	S			
	10^{-3}			Absorbed with C203 matt		S	S	D1	S	S	S			
	10^{-4}			Not absorbed	D3	S	S	D5	S	S				
	10^{-4}			Absorbed with C203 matt	D2	S	S	S	S	S				
" " "	10^{-4}	1	Type 1 matt	Not absorbed	S	S	S	S	S	S	S	S	D2	D2
	10^{-4}			Absorbed with C203 matt†	S	S	S	S	S	S	D2	D2	D1	D2
" " "	10^{-3}	1	S118 matt	Not absorbed	S	S	S	S	S	D5	S	D1	D1	D1
	10^{-3}			Absorbed with C203 matt	S	S	S	S	D1	D1	D2	D1	D1	D1
	10^{-4}			Not absorbed	S	S	S	S	S	S				
	10^{-4}			Absorbed with C203 matt	S	D3	S	S	S	S				
" " "	10^{-4}	1	J131 matt	Not absorbed	D1	D1	S	S	D2	D12				
	10^{-4}			Absorbed with C203 matt	D1	S	D1	S	S	D1				
C203 matt	10^{-4}	C203	C203 matt	Not absorbed	D2	S	S	S	S	S				
	10^{-4}			Absorbed with C203 matt	D1	D2	D1	D1	D1	D2				

See Table I, preceding paper, for footnotes.

D indicates death within the number of days indicated by the numeral.

S indicates survived for 2 weeks.

* Absorption of type 1 serum with type 1 matt strains regularly removed the protective antibody, *cf.* Table I, preceding paper.

† In an earlier experiment, the protective antibody for type 1 was absorbed from this serum by strain C203 matt, but this was attributed to technical difficulties since it could never be repeated in subsequent experiments.

strain C203 matt revealed that it was identical in its serological behavior with type 3 M extract. These results are shown in section B of Tables III and IV. M extracts of strain C203 matt and of a type 3 matt strain precipitated the same unabsorbed antisera, prepared against either strain (columns 3 and 4), but gave negative precipitin reactions after these anti-

sera had been specifically absorbed with bacteria from either of these strains. Absorption with the type 3 glossy strain, which contained no M substance, or absorption with either of the type 1 variants did not affect the M precipitin reactions with extracts of strain C203 matt and type 3 matt. The summary of the protection tests with these sera (section C, Tables III and IV) shows that protective antibody always paralleled M precipitin.

TABLE III

Relationship of Strain C203 to Types 1 and 3

Immunological Reactions in Type 3 Matt Antiserum

Type 3 matt antiserum	*Section A* Agglutinations with culture of					*Section B* Precipitin reactions with M extract of					**Section C* Passive protection in mice against infection with culture of		
	Type 1 matt	Type 1 glossy	C203 matt	Type 3 matt	Type 3 glossy	Type 1 matt	Type 1 glossy	C203 matt	Type 3 matt	Type 3 glossy	Type 1 matt	C203 matt	Type 3 matt
Not absorbed	−	−	±†	+++	++++	+	−	++++	++++	−	D	S	S
Absorbed with bacteria of													
Type 1 matt	−	−	±	+++	++++	−	−	++++	++++	−		S	S
Type 1 glossy	−	−	±	+++	++++	−	−	++++	++++	−		S	S
C203 matt	−	−	−	−	−	−	−	−	−	−		D	D
Type 3 matt	−	−	−	−	−	−	−	−	−	−		D	D
Type 3 glossy	−	−	±	++	−	−	−	++++	++++	−		S	S

See Table 1 for meaning of symbols.

* These protection experiments are given in detail in Table I, preceding paper (1), and in Tables V and VI of the present paper.

† Some suspensions of strain C203 agglutinate in type 3 antisera, but others do not. Such suspensions, however, absorb all type 3 antibodies.

The glossy variant of strain C203 reverted to the matt form during the course of these experiments, and has not so far been recovered in the experiments performed for that purpose. Consequently, all experiments with it have been omitted.

Reciprocal Protection Test with Unabsorbed Sera.—The differentiation of strain C203 from type 1 in respect to M antigen and its similarity in this respect to type 3 were borne out by protection tests with unabsorbed sera of these types.

Four type 1 antisera, prepared with strains T1, S118, and J131 respectively, two antisera, prepared with strain C203, and two type 3 antisera, prepared with strains T3 and P279 respectively, were injected intraperitoneally in 0.5 cc. amounts into five sets of mice. On the following day, 0.5 cc. of serial dilutions of culture were inoculated intraperitoneally into the mice so that each serum was tested against each of the following strains: type 1 strains, T1 and S118; strain C203; and type 3 strains, T3 and P279. Control series of mice without serum were included for each culture tested.

The results set out in Table V show clearly that the four type 1 sera protected well against the type 1 strains, but not against strain C203 or either of the type 3 strains; while the two strain C203 antisera and the two type 3 antisera behaved alike in protecting against strain C203 and the type 3 strains. These results, therefore, were consistent with the presence in strain C203 of the M substance characteristic of type 3.[1]

In spite of this fact, strain C203 matt either did not agglutinate at all or only slightly in type 3 matt antisera, although type 3 matt strains were, as a rule, agglutinated in the presence of either M or T antibodies of type 3.

TABLE IV

Relationship of Strain C203 to Types 1 and 3
Immunological Reactions in Antiserum Prepared with Strain C203 Matt

Antiserum against strain C203 matt	*Section A* Agglutinations with culture of					*Section B* Precipitin reactions with M extract of					**Section C* Passive protection in mice against infection with culture of		
	Type 1 matt	Type 1 glossy	C203 matt	Type 3 matt	Type 3 glossy	Type 1 matt	Type 1 glossy	C203 matt	Type 3 matt	Type 3 glossy	Type 1 matt	C203 matt	Type 3 matt
Not absorbed	++++	++++	++++	+++	++++	±	−	++++	++++	−	D	S	S
Absorbed with bacteria of													
Type 1 matt	−	−	++	+++	++++	−	−	++++	++++	−	D	S	S
Type 1 glossy	−	−	++	+++	++++	−	−	++++	++++	−			
C203 matt	−	−	−	−	−	−	−	−	−	−	D	D	D
Type 3 matt	++++	++++	++++	−	−	−	−	−	−	−	D	D	D
Type 3 glossy	++++	++++	++++	++	−	−	−	++++	++++	−		S	S

See Table I for meaning of symbols.

* These protection experiments are given in detail in Table I, preceding paper (1), and in Tables V and VI of the present paper.

This inconsistency in agglutination of strain C203 matt in type 3 antisera was partially explained by finding that the strain absorbed all demonstrable antibodies, including agglutinins, precipitins, and protective antibodies, from type 3 matt antisera, just as well as did homologous type 3 matt strains (Table III, second and third rows from the bottom of the table). Since streptococci may vary in agglutinability, even though known to contain the requisite antigens, this peculiar irregularity of strain C203 in its agglutination in type 3 antisera was not considered significant in analyzing its content of type 3 antigens. The reciprocal relationships shown in the M precipitin reaction and the protection tests together with the absorptive

[1] Active and passive protection of mice against infection with strain C203 following immunization with an extract of a type 3 strain was recorded previously (3).

TABLE V

Relationship of Strain C203 to Types 1 and 3

Passive Protection Tests in Mice with Unabsorbed Sera

Infecting strain for protection test		Type 1 matt antiserum				C203 matt antiserum		Type 3 matt antiserum	
		0.5 cc. undiluted serum from rabbit immunized with matt strain							
		T1	T1	S118	J131	C203	C203	T3	P279
	cc.								
Type 1 matt (type 1)	10^{-6}	S	S	S	S	D2	D5	D1	S
	10^{-5}	S	S	S	D2	D1	D2	D1	S
	10^{-4}	S	S	S	S	D1	D1	D1	D1
	10^{-3}	D5	S	S	S	D1	D1	D1	D1
	10^{-2}	S	S	S	S	D1	D1	D1	D1
	10^{-1}	D1	D1	D1	D1	D1	D1	D1	D1
S118 matt (type 1)	10^{-8}					D1	D5	S	D4
	10^{-7}					D1	D2	D1	D1
	10^{-6}	S	S	S	S	D1	D1	D2	D2
	10^{-5}	S	S	S	S	D1	D1	D2	D5
	10^{-4}	S	S	S	S	D1	D1	S	D1
	10^{-3}	S	D1	S	D7	D1	D1	D1	D1
	10^{-2}	D1	D1	D1	D7				
	10^{-1}	D1	D1	D1	D1				
C203 matt (type C203)	10^{-8}		D1						
	10^{-7}		D1						
	10^{-6}	D2	D1	D2	D2	D4	S	S	S
	10^{-5}	D1	D1	D1	D1	S	S	S	S
	10^{-4}	D1	D1	D2	D1	S	S	S	S
	10^{-3}	D1	D1	D1	D1	S	S	S	S
	10^{-2}	D1		S	D1	D1	D1	D1	D1
	10^{-1}	D1		D1	D1	D1	D1	D1	D1
Type 3 matt (type 3)	10^{-8}	Not done	D2	D1	Not done	S	S		
	10^{-7}		D1	D1		S	S		
	10^{-6}		D1	D1		S	S	S	S
	10^{-5}		D1	D1		S	S	S	S
	10^{-4}		D1	D1		S	S	S	S
	10^{-3}		D1	D1		S	S	S	S
	10^{-2}					D2	S	S	S
	10^{-1}					D1	D1	D1	D1
P279 matt (type 3)	10^{-8}	D1	D1	S	S				
	10^{-7}	D2	D1	D1	D1	S	S		
	10^{-6}	D1	D1	D1	D1	S	S	S	S
	10^{-5}	D1	D1	D1	D1	D4	S	S	S
	10^{-4}	S	D1	D1	D1	S	D6	S	S
	10^{-3}	D1	D1	D1	D1	D1	S	S	S
	10^{-2}					D1	D1	S	S
	10^{-1}							S	D1

D indicates death within the number of days indicated by the numeral.

S indicates survived for 2 weeks.

Virulence controls with each experiment included mice receiving all dilutions of cultures used but no serum. The M.L.D. was at least 10^{-7} cc. and usually 10^{-8} cc.

See Table I, preceding paper, for other footnotes.

capacity of the strain seemed sufficient and convincing evidence of the presence in strain C203 of the M and T antigens of type 3.

Reactions of Strain C203 and Strains of Types 1 and 3 in Antiserum Prepared with Strain C203 Matt.—This analysis of the antigens contained in strain C203 was further supported by investigation of the antibodies formed in response to immunization with this strain. The precipitin reactions (Table IV, section B) of C203 matt antiserum, either unabsorbed or absorbed with variants of the three strains concerned, showed that it contained precipitins for type 3 M substance and not for type 1 M substance, while the agglutination reactions (section A) showed agglutinins for matt and glossy strains of types 1 and 3, as well as for the homologous strain.

Absorption of this serum with matt or glossy strains of type 1, or with matt strains of type 3 removed the agglutinins entirely for the respective absorbing type, but not at all for the other, and only partly in either case for strain C203. The latter strain, which contained type-specific antigens in common with both types 1 and 3, was agglutinated by whichever type antibody remained in the absorbed serum. Absorption with the type 3 glossy strain removed all agglutinin for itself, that is the type 3 T antibody, but left the type 3 M antibody, which was responsible for the continued agglutination of the type 3 matt strain and for part of that of strain C203 matt. The type 1 variants, as well as strain C203 matt were still agglutinated by the type 1 T antibody left in this serum absorbed with the glossy variant of type 3.

The reciprocal protection tests, summarized in Tables I, III, and IV, are given in full in Table I of the preceeding paper (1) and in Tables V and VI of this paper. These results show that the protective antibody is parallel to the anti-M precipitin: Type 1 matt antiserum protected against type 1 strains only (Table V) and its protective antibody was absorbed only by type 1 matt strains or M substance extracted from them (Table I, preceding paper). Neither type 3 nor strain C203 matt antisera protected against type 1 strains (Table VI, sections A and B); but both protected against type 3 strains and strain C203 (Table VI, first row of sections C to F). Both were deprived of protective antibody by absorption with either strain C203 or type 3 matt (same sections, 3rd and 4th rows); but not by absorption with type 1 matt (same sections, 2nd row), or by absorption with glossy strains (same sections, last row).

It seems clear from all the immunological reactions tested in these reciprocal absorption experiments with strain C203 and strains of types 1 and 3 that strain C203 matt contains M and T antigens characteristic of type 3, and T antigen, but not M antigen, characteristic of type 1. For the prac-

tical differentiation of an anomalous strain like C203 it is, therefore, essential to test it by both agglutinin and precipitin reactions, since neither test

TABLE VI

Relationship of Strain C203 to Types 1 and 3

Passive Protection Tests in Mice with Absorbed Sera

Treatment of serum	Infection with 10^{-4} cc. strain	Type 3 matt antiserum, 0.5 cc. serum diluted							C203 matt antiserum, 0.5 cc. serum diluted						
		1:2	1:4	1:8	1:16	1:32	1:64	1:128	1:2	1:4	1:8	1:16	1:32	1:64	1:128
		Section A							*Section B*						
Not absorbed	Type 1 matt	No protection*							D2	D2	S	D1	D2	D2	D2†
Absorbed with															
Type 1 matt	"	Not done							D4	D2	D1	D1	D1	D3	
C203 matt	"	" "							D1	D1	D2	D2	D1	D1	
Type 3 matt	"	" "							D1	D1	D1	D1	D2	D2	
		Section C							*Section D*						
Not absorbed	C203 matt	S	S	S	S	D2	S	S†	S	S	D2	S	S	S	S‡
Absorbed with															
Type 1 matt	"	S	S	S	S	D4	D1	D2†	S	S	S	S	S	D2	D1†
C203 matt	"	D1	D1	D1	D1	D1	D2		D1	D1	D1	D1	D1	D1	
Type 3 matt	"	D1	D1	D1	D1	D1	D1		D1	D1	D1	D1	D1	D1	
Type 3 glossy§	"	S	S	S	S	D4	S	S†	S	S	D4	D9	D3	D4	D4†
		Section E							*Section F*						
Not absorbed	Type 3 matt	S	S	S	S	S	D2	S†	S	S	S	S	S	S	S‡
Absorbed with															
Type 1 matt	"	S	S	S	D2	D2	D5	D1†	S	D2	S	S	S	S	D1†
C203 matt	"	D1	D1	D1	D1	D1	D1		D1	D1	D1	D1	D1	D1	
Type 3 matt	"	D1	D1	D1	D1	D1	D1		D1	D1	D1	D2	D1	D1	
Type 3 glossy§	"	S	S	S	S	D2	S	S†	S	S	S	S	D6	S	D4†

* An excess of this serum failed to protect mice against type 1 matt as follows:

Mouse No.	0.5 cc. undiluted type 3 matt serum, Type 1 matt culture			
	10^{-7} cc.	10^{-6} cc.	10^{-4} cc.	10^{-2} cc.
1	D2	D2	D1	D1
2	D2	D2	D1	D1
3	D3	D2	D1	D1

See Table I, preceding paper (1), for footnotes as to methods and virulence controls.

† All mice receiving higher dilutions of serum died.

‡ This serum in a dilution of 1:512 protected mice against infection with strain C203 and type 3.

§ The absorption experiment with type 3 glossy was done at a different time from the others.

alone will fully establish its identity. Use of the agglutination reaction alone would indicate that strain C203 belongs in type 1, while use of the precipitin reaction or protection test alone would indicate that it belongs in type 3. Both statements are true as far as they go. By applying to this

particular case the general principles worked out in the analysis of the immunological relationships of matt and glossy variants of several types (1), it has been possible to explain the peculiar immunological reactions of strain C203 as due to its unusual structure in containing antigens characteristic of more than one serological type.

DISCUSSION

It was found in previous work that the occurrence of the type-specific protein, M, and the newly recognized type-specific factor, T, are usually completely correlated in any given type; so that in the four types studied a matt strain of a given type contains the M substance of that type and the corresponding T substance characteristic of the same type (1). The present report deals with the application of knowledge concerning the two kinds of type-specific antigens to the analysis of an unusual strain, C203, which in addition to the two type-specific antigens, M and T, characteristic of type 3, contains the agglutinogen, T, peculiar to type 1. This strain does not have the type 1 M substance. All the hitherto confusing reactions of this strain are adequately explained on the basis of these three antigenic factors. Thus, strain C203 gives all the type-specific reactions of type 3 strains, dependent upon type 3 M and T antigens, and also the agglutination reactions characteristic of type 1 and dependent upon type 1 T antigen. It does not give the M precipitin and protection reactions of type 1 since it does not contain type 1 M antigen.

The possibility of such an association of antigens within one strain may furnish the clue to vaguely understood interrelationships of this sort, such as the cross agglutination observed by Pauli and Coburn (4) by Kodama and his associates (5), and by Rudd, White, and Ward in Australia (6) to occur between group A strains of types 17 and 23. Other instances of possibly similar cross relationships are known but have not been studied.

SUMMARY

In any one strain the occurrence of the previously recognized type-specific protein, M, is usually completely correlated with the presence of the recently recognized type-specific antigen, T. Strain C203 is exceptional in having the T substance of type 1 as well as the two type-specific antigens, M and T, characteristic of type 3. It does not have the M antigen of type 1. While other strains with similar antigenic peculiarities have not been encountered, it is probable that they occur, and the existence of such anomalies must be suspected when unusual serological reactions occur.

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