TWO DIFFERENT VARIETIES OF STAPHYLOCOCCUS
AUREUS BASED ON THE CORRELATION BETWEEN
ANTIGENIC STRUCTURE, PHAGE PATTERN,
ANTIBIOTIC PATTERN AND VIRULENCE

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SUMMARY. The majority of recent isolates of Staphylococcus aureus can be separated into two varieties and these may correspond to the original antigenic forms of Cowan's serotypes I and III.

The most common variety has antigen 17 or 1 as a surface antigen and is lysed by serological group B phages; it may contain serological group A prophages and is usually tetracycline sensitive. It is probably more virulent (particularly in the 17+ form) than the second variety which possesses antigen 13 or 3, and is lysed by serological group A phages and may contain B prophages. It is usually tetracycline resistant.

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Cowan (1939), using slide agglutination tests, found that the majority of coagulase-positive staphylococci could be divided into three serotypes. However, the original strains of Cowan's serotypes I and III when obtained from culture collections possess antigenic structures that are different to that of most strains usually isolated these days; instead, most isolates now possess either antigen 17 (40%) or antigen 13 (20%), (Torres Pereira, 1960). Antigens 17 or 13 of these strains are easily lost on subculture in the laboratory and give rise respectively to antigen 1 or 3; phage patterns (Professor R. E. O. Williams pers. comm.) and antibiotic sensitivity patterns remain unchanged. This phenomenon has been called antigenic loss variation by the author (Torres Pereira, 1961) and it is suggested that originally Cowan I and III serotypes possessed respectively antigens 17 and 13 and not 1 and 3 which they now contain.

The author has been examining the relationship of strains with antigen 17 or 1 and 13 or 3 to their phage typability, serological grouping of lysing phages, antibiotic sensitivity, and finds further evidence for antigenic loss variation among S. aureus strains.

Antigenic Structure and Virulence

Mice were inoculated intracerebrally with a single strain S. aureus (strain 13346) which originally possessed antigen 17 but after 65 subcultures contained antigen 1 in place of 17. The results (Table I) show that the original form (17⁺ 1⁻) was more virulent than the final form (17⁻ 1⁺); the results have a statistical significance: $\chi^2 = 75.2$; $p < 0.01$.

Antigenic Structure and Phage Typing

Fifty-eight of 96 strains (60%) with antigen 17 or 1 are lysed by group I phages and 69 out of 92 strains (75%) with antigen 13 or 3 are lysed by group III phages; complete results are shown in Table II.

Antigenic Structure and Serological Group of Lysing Phage

Strains used to propagate phages 29, 52, 52A, 79, 80, 55 and 71 of the basic phage typing set (Williams and Rippon, 1952) are lysed by serological group B phages and possess on their surface, antigen 17 or 1; also strains used to propagate phages 6, 7, 43E, 47, 54 and 73 are lysed by serological group A phages and have antigen 13 or 3 as their surface antigen. It is accepted by many workers that a strain carrying a prophage of one serological group is only lysed by a phage of the other serological group. Thus it might be expected that a strain lysed by a serological group B phage will carry a serological group A prophage and vice versa.

Antigenic Structure and Antibiotic Sensitivity Patterns and Virulence

Only 10% of strains with antigen 17 or 1 are resistant to tetracyclines whereas 70% of strains with antigen 13 or 3 are resistant to tetracyclines; resistance to penicillin and

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Table I. Loss variation and virulence in Staphylococcus aureus (intracerebral inoculation in mice).

Strains inoculated	Condition of animals 48 hr. after intracerebral inoculation		Total of inoculated mice: 236
	Alive	Dead	
Strain 43346 "original" 17 ⁺ 1 ⁻	48	102	150
Strain 43346 "final" 17 ⁻ 1 ⁺	78	8	86

Table II. Antigenic structure and phage typing (209 strains of Staphylococcus aureus).

Antigenic structure	Phage typing group				Total
	I	II	III	IV or NT	
Antigen 17 or 1	58	13	21	4	96
Antigen 13 or 3	7	11	69	5	92
Other or unidentified antigens	2	1	14	4	21
Total	67	25	104	13	209

NT = Not typable.

Figure 1. Association of several characters in two different varieties of Staphylococcus aureus.

With antigen 17 (or 1)
 With prophage A?
 Lysed by B phages
 Tetracycline sensitive (90%)
 More virulent (in 17⁺ form)

With antigen 13 (or 3)
 With prophage B?
 Lysed by A phages
 Tetracycline resistant (70%)
 Probably less virulent

streptomycin is not very different for all strains. It has been shown previously (Torres Pereira, 1962) that tetracycline resistant mutants are easily destroyed by injection into mice and that only the tetracycline-sensitive strains are highly pathogenic to this animal.

DISCUSSION AND CONCLUSION

The correlation of antigenic structure with different properties of S. aureus indicates an intimate association of several characters in two different varieties of S. aureus; this association is displayed in Fig. 1. It is suggested that the many phage patterns and antigenic formulae of S. aureus strains, although important for epidemiological studies, are probably based on slight variations of these two main varieties of S. aureus.

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