NOTES

Proposals for Improving the Classification of Members of the Genus *Shigella*

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With respect to *Shigella flexneri*, serovar 6 should be transferred to *S. boydii*; serovar 5 should be divided into two subserovars, 5a and 5b, with antigenic formulas V:(4) and V:7, respectively; and serovar 3 should contain only two subserovars, 3a-III:(3,4),6 and 3b-III:(3,4),6,7,8. Concerning the six provisional *Shigella* serovars, serovar 2000-53 should be removed from the genus because it belongs to the genus *Escherichia*, the position of serovar 1624-54 is still under consideration, serovars 3873-50 and 3341-55 should be placed in *S. dysenteriae* as serovars 11 and 12, respectively, and serovars 2710-54 and 3615-53 should be considered as members of *S. boydii* serovars 16 and 17, respectively.

In the past, many difficulties were encountered in classifying the members of the genus *Shigella*, and the problem of the classification of the infrasubspecific forms of *S. flexneri* is still under consideration. For example, scientists from different countries have indicated the necessity of removing serovar 6 from *S. flexneri* because its properties differ greatly from those of other members of this species. These differences include fermentative properties (2, 15), the range of susceptibility to phages and colicins, the immunochemical and immunoelectrophoretic characteristics of the antigens, and genetic characteristics (4, 5, 8, 12-15).

Recent immunochemical data have also shown the necessity of excluding serovar 6 from *S. flexneri*. The lipopolysaccharide of serovar 6, contrary to the lipopolysaccharides of the other serovars of *S. flexneri*, contains *N*-acetylgalactosamine instead of *N*-acetylglucosamine (5), a sugar of the immunodeterminant group of antigens 3 and 4 (10-12). Significant genetic differences have also been demonstrated: serovar-specific antigen VI is controlled by the chromosomal gene located near the *his* marker (8). Antigens I through V are the result of the modification of the basal lipopolysaccharide structure (antigens 3 and 4), which is controlled by the corresponding converting prophages localized near the *lac* marker (8, 9, 14, 15).

We believe that *S. flexneri* serovar 6 is close to *S. boydii* and that it should be transferred to this species. Ewing (2) placed it between *S. flexneri* serovars 1 through 5 and *S. boydii*. *S.*

flexneri serovar 6 is closer to *S. boydii* than to *S. flexneri* on the basis of its biochemical properties (2), the percentage of colicinogenic strains, the type of colicins produced (14), and the immunochemical structure of its lipopolysaccharide (5). An analysis of the chemovars of *S. boydii* (1) permitted the determination of the position of serovar 6 as being intermediate between that of chemovars III and IV of *S. boydii* (8). It may be designated as *S. boydii* 18, for instance (see below, concerning serovars 16 and 17). It is known that in *S. boydii* there is no correlation between serovars and the lipopolysaccharide chemotypes. The strains of the same chemotype do not give cross-reactions; the only serovars (10 and 11) which give such reactions belong to different chemotypes (1).

Supporting the division of serovar 5 into subserovars 5a and 5b are the independent occurrence in nature of strains with the antigenic formula V:(4) or V: 7 (6) and differences in the genetic behavior of these strains (8, 9, 14, 15). This division has also been supported by the results of immunochemical investigations (10, 11, 19).

Serovar 3 should also be reconsidered. As mentioned above, antigens 3 and 4 are the basic structures in the lipopolysaccharides of serovars 1 through 5. Antigens 3 and 4 may be present in strains of any of the subserovars 1 through 5, resulting in the loss of the corresponding prophages. It seems irrational to increase the number of subdivisions of serovar 3 merely on the basis of a single variable character (the presence

or absence of antigens 3 and 4) which distinguishes subserovar 3b from 3a (3). To unify the nomenclature of *S. flexneri*, it seems advisable to recognize only two subserovars of serovar 3, 3a and 3b. Strains with the formula III:(3,4), 6 would be members of subserovar 3a, and those with formula III:(3,4),6,7,8 would be members of subserovar 3b (8). In this case, all subserovar "a" strains would be monolysogenic and would turn into variant "Y" after loss of the corresponding prophages. Strains of subserovar "b" are bilysogenic and are characterized by more complicated variations in their antigenic structure (Fig. 1).

The proposed division may also be convenient in medical practice. Figure 1 may be used by epidemiologists in analyzing "change of types" observed in natural conditions in differentiating the above-mentioned antigenic variability from superinfection or mixed infections.

In summary, it is suggested that the classification of *S. flexneri* serovars be changed as follows (Table 1). (i) Serovar 5 should be removed from *S. flexneri* and transferred to *S. boydii*. (ii) Serovar 5 should be divided into two subserovars, 5a and 5b, with antigenic formulas V:(4) and V:7, respectively. (iii) Serovar 3 should be divided into only two subserovars, 3a and 3b, with formulas III:(3,4),6 and III:(3,4),6,7,8, respectively.

As for the so-called provisional serovars, one of them, 2000-53, should be excluded from *Shigella* because its fermentation pattern is typical of *Escherichia*. It grows on acetate agar, alkalizes Christensen citrate and litmus milk, and is resistant to the phage which is specific for the genus *Shigella* (7). Thus, strains of serovar 2000-53 are anaerogenic, lactose-nonfermenting, non-motile members of *E. coli* whose antigenic formula is 06a,06b:K?:H-. Strains of provisional serovars 3873-50 and 3341-55, which correspond to *S. dysenteriae* on the basis of their cultural and biochemical properties, should be regarded

TABLE 1. Proposed classification of *S. flexneri* serovars

Serovar	Subserovar	Antigenic formula (abbreviated)
1	1a	I:4
	1b	I:(4),6
2	2a	II:3,4
	2b	II:7,8
3	3a	III:(3,4),6
	3b	III:(3,4),6,7,8
4	4a	IV:(3,4)
	4b	IV:(3,4),6
5	5a	V:(4)
	5b	V:7
	var. X	—:7,8
	var. Y	—:3,4

as strains of serovars 11 and 12, respectively, of *S. dysenteriae*. Provisional serovars 2710-54 and 3615-53 should be regarded as serovars 16 and 17, respectively, of *S. boydii* for the same reasons. The status of serovar 1621-54 should remain provisional until further strains can be collected and studied.

REPRINT REQUESTS

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FIG. 1. Suggested relationships of *S. flexneri* serovars.

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