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TRANSDUCTIONAL ANALYSIS OF MONOPHASIC TYPES OF SALMONELLA

(Report by Tetsuo Iino and Joshua Lederberg*)

The specificity of flagellar (H) antigen in Salmonella is controlled by two distinct loci, phase-1 by H_1 and phase-2 by H_2. Which one is manifested in a given clone depends on the phase determinant at the H_2 locus. That is, the alternation of H_2 state leads to the alternative expression, which has been known as phase variation of H-antigen (the Annual Report, 1956).

Some Salmonella strains do not express two phases but only one. Those strains are called monophasic-1 or -2 strains depending on their fixed phase, either phase-1 or phase-2 respectively. Three additional groups of the genes which are involved in the production of H antigen were disclosed by transductional analysis of the monophasic strains.

S. abortus-equi CDC-26 is stable in phase-2, enx-type. A rare alternative phase can occasionally be obtained by antiserum selection, resulting in equally stable phase-1 (a). Transductions were carried out from enx-phase of CDC-26 to i-phase of a diphasic strain of S. typhimurium, TM2 i:1.2 (such transduction is designated CDC-26 (a):enx → TM2 i:1.2). Among 65 transductional clones which had been selected on semisolid nutrient gelatine-agar media (NGA), 4 expressed diphasic a:1.2 type, 42 diphasic i:enx and 19 monophasic-2 enx which carry a hidden H_1^i. Thus, when a is transduced ~~a fraction of the transductional clones become monophasic.~~

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the resulting transductions remain diphasic, whereas when enx is transduced a fraction of the transductional clones become monophasic. By anti-enx selection, i-phase cultures were obtained from the monophasic enx-transductional clones. The i-phase cultures obtained are also monophasic. The stabilization of the H_2 state in S. abortus-equi is therefore caused by a factor which is linked to H_2. The factor will be given a symbol Vh_2^-.

S. typhimurium SW1061 is a monophasic-2 mutant of a diphasic strain TM2 i:1.2. The culture reacts to anti-1.2 serum but not to anti-i serum. However, the strain frequently produces nonmotile H-negative (non-flagellar) subclones, which in turn revert to motile cells with 1.2 antigen in successive cultures. From the transduction, diphasic S. abony CDC-103 b:enx --x SW1061, monophasic-2 enx, diphasic b:1.2 and a small number of i:1.2 types were obtained. The change from the monophasic type to diphasic types was always coupled with the loss of the ability to oscillate between motile and non-motile types. These results are consistent with the following explanation. In SW1061, H_1^i is inactive; on the other hand $H_2^{1.2}$ changes its state as in usual diphasic strains. Consequently, when H_2 is active, phase-2 antigen, 1.2, is produced, and when H_2 changes to inactive, that is both H_1 and H_2 are inactive, the cell

cannot
produce H antigen and become non-motile. The production of diphasic i:1.2 type suggests that the inactivation of H_1 is not caused by an intrinsic change of H_1 itself but by an inhibition of its function by a gene linked to H_1. The linkage and the recombination between H_1 and H_1-activity controller were confirmed on Fla_1^+ (linked to H_1) transductions from SW1061 --x S. heidelberg Fla_1^- r:1.2, from which monophasic-2 -(i):1.2 and diphasic i:1.2 as well as diphasic r:1.2 were obtained.

The H_1-activity controller is designated Ah_1^-. Ah_1^- was discovered in two other monophasic-2 strains of S. typhimurium , SW629 and SW547. All of three Ah_1^- are non-allelic and linked to H_1 and Fla_1. The paired type of gene, Ah_2^-, which inhibites the function of H_2 was disclosed on four monophasic-1 strains of S. typhimurium . All of them are linked to H_2. Both Ah_1 and Ah_2 are phase specific but are not concerned with the specificity of antigen types, which are determined exclusively by H_1 and H_2. (the detail will be reported in)