A Transducing Bacteriophage for Proteus vulgaris

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Bacteriophages which transduce genetic markers in Proteus mirabilis (1, 2) P. morganii (3) and Providence (4) have been reported.

In the course of an investigation of lysogeny in local strains of Proteus vulgaris, strain 107 was found lysogenic for P. vulgaris strain 69. The phage (named 107/69) produces turbid plaques on strain 69 and its ability to transduce markers into the strain was investigated using methods previously described (1, 4). A chloroform-sterilized lysate of strain 69 str-r can transduce the marker to wild strain 69 at a rate of $3 \times 10^{-6}$ plaque forming units adsorbed, and similar lysates of wild strain 69 convert auxotrophs to prototrophy at the same rates showing that the phage is capable of generalized transduction. As in transduction with other proteus phages (4) abortive transductants were not detected.

![Graph](image)

Fig. 1. Effect of ultraviolet irradiation on plaque forming and transducing abilities of phage 107/69 produced on strain 69 str-r. The phage suspension was irradiated at 10 ergs/mm.²/sec. At intervals samples were used in quantitative transduction experiments. The recipient was wild strain 69 with selection for streptomycin resistance (O). Plaque-forming titre of samples (●).

All transductants were lysogenic for phage 107/69 and immune to it. As with Providence transducing systems (4), other markers may be transduced into lysogenized transductants at rates about half those of non-lysogenic recipients (Table 1). The differential effect of ultraviolet (u.v.) light on plaque forming and transducing abilities of the phage is shown in Fig. 1. Like Proteus morganii phage M (4) and Pseudomonas aeruginosa phage F116 (8), the transduction frequency of markers decreases expon-
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entially with time of irradiation. With other systems a rise in transduction frequency is found with small doses of u.v. light due to an increase in frequency of exchange between exogenote and bacterial chromosome. Present results may mean that the transduced element does not recombine with the recipient chromosome to yield the selected genotype. Rather the transduced element may persist as part of the prophage which is susceptible to one-hit inactivation kinetics (9).

When DNAs were extracted from phage 107/69 and Proteus vulgaris strain 69 and their base compositions compared (4), the guanine + cytosine molar content of the phage DNA was 39.8% compared to 38.5 for the bacterium. With the exception of Bacillus subtilis phages close correspondence between the guanine + cytosine content of a transducing phage and its bacterial partner is the rule (4).

Table 1. Re-transduction of lysogenic transductants

<table>
<thead>
<tr>
<th>Recipients</th>
<th>Prototrophs</th>
<th>Str-r</th>
</tr>
</thead>
<tbody>
<tr>
<td>69 met-4</td>
<td>715</td>
<td>1150</td>
</tr>
<tr>
<td>69 met-4 proto. transd.</td>
<td>--</td>
<td>650</td>
</tr>
<tr>
<td>69 met-4 str-r transd.</td>
<td>362</td>
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Electron microscopy of phage 107/69 revealed a head which is probably octahedral with an inter-apex distance of 660 Å and a tail 1320 Å in length surrounded by a contractile sheath (Plate). It is the only known Proteus transducing phage with a tail (4, 7).

Adsorption to strain 69 is Ca²⁺-independent and the phage undergoes 99.9% inactivation at 60° for 15 min.

Proteus vulgaris and P. mirabilis are related and have been grouped in single species 'vulgaris' or 'hauseri' (5), but the tendency (6) is to grant each separate rank in a genus Proteus. Many phages active on P. vulgaris also lyse P. mirabilis and vice versa (10). Phage 107/69 has no action on 164 different strains of P. mirabilis tested. The situation is analogous to that encountered with P. mirabilis transducing phages. None of the latter attack P. vulgaris strains (4). Phage 107/69 also has no action on strains of other members of the Proteus-Providence group tested.

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EXPLANATION OF PLATE

Electron micrographs of preparations negatively stained with phosphotungstic acid. Fig. 1, 2 at the same magnification. The bar represents 1000 Å.

Fig. 1. Phage 107/69 with tail sheath uncontracted.

Fig. 2. Phage 107/69. The head has an octahedral shape and the tail sheath is contracted.