NOTES

Coliforms from Hides and Meat

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Coliform tests were performed on 85 hide and 75 meat samples. IMViC reactions were determined on isolates from positive confirmed and fecal tests, and strains other than *Escherichia coli* were identified. Strains typed as *Aerobacter aerogenes* types I and II were identified as *Enterobacter cloacae* (51.4%), *Klebsiella pneumoniae* (21.5%), *Enterobacter aerogenes* (15%), and *Enterobacter liquefaciens*, *Serratia*, and unidentified coliforms (12.1%). *K. pneumoniae* appeared to be responsible for <1% positive fecal tests.

Most of the coliforms on meat probably originate from contamination on the hide of the animal (9). This contamination could be of enteric origin but may also come from soil and vegetation. Data on the occurrence of coliforms on meat and meat products have been obtained using selective media (3, 10; M. Catsaras and D. Grebot, Abstr. Eur. Meet. Meat Res. Work., 20th, p. 237, 1974) and by IMViC typing of cultures (5). However, IMViC reactions alone fail to distinguish between species of *Enterobacter* or between *Enterobacter* and *Klebsiella.* This study was undertaken, therefore, to gather more information on the identity of organisms from hides and meat that give positive reactions in American Public Health Association coliform testing procedures (1). Such information is required for assessing the significance of the tests when applied to meat.

Eighty-five hides and 75 meat samples from a meatworks were examined over an 8-week period. Areas measuring 100 cm² each were sampled with two sterile swabs moistened with 0.1% (wt/vol) peptone water, and the swabs were examined by American Public Health Association coliform testing methods (1). Difco lactose broth, brilliant green lactose bile broth, and BBL EC medium were used for the presumptive, confirmed, and fecal tests, respectively.

Broth from positive confirmed and fecal tests was streaked onto Difco EMB agar plates which were incubated for 24 h at 35°C. Representa-
tives of all colony types were transferred to plates of Difco plate count agar and bottles of lactose broth. Cultures that produced gas in 48 h at 35°C were tested for reaction in O/F medium, motility, catalase, oxidase, and Gram stain. Those giving reactions typical of coliforms were examined for IMViC reactions by American Public Health Association methods (1). Cultures other than *Escherichia coli* types I and II (+ + + + and - - - -) were identified with the BBL Minitek differentiation system (7). Coliforms other than *E. coli* isolated from positive fecal tests were also examined for their reaction in pure culture in the fecal test.

All 160 samples gave positive presumptive and confirmed tests, and 144 fecal tests were positive. Strains of *Pseudomonas* occurred on some EMB plates, but all lactose-fermenting isolates were coliforms. One hundred and sixty-six out of 392 isolates gave IMViC reactions different from those of *E. coli* types I and II, and the identities of these isolates are shown in Table 1.

*E. coli* was recovered from 100 of the confirmed tests and other coliforms from 55 tests. In all, 117 coliforms other than *E. coli* were

<table>
<thead>
<tr>
<th>Identified as:</th>
<th>IMViC type</th>
<th>Aerobacter aerogenes</th>
<th>Intermediate</th>
<th>Other combinations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I II I II</td>
<td></td>
<td></td>
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<tr>
<td><em>Enterobacter cloacae</em></td>
<td>45 10 0 0 2</td>
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<tr>
<td><em>Citrobacter</em></td>
<td>0 0 21 4 2</td>
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<td><em>Enterobacter aerogenes</em></td>
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<tr>
<td><em>Klebsiella pneumoniae</em></td>
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<td></td>
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<tr>
<td><em>Enterobacter liquefaciens</em></td>
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<tr>
<td><em>Serratia</em></td>
<td>1 0 0 0 0</td>
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<td></td>
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</tr>
<tr>
<td><em>Escherichia coli</em></td>
<td>0 0 1 13 9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unidentified</td>
<td>10 1 1 0 1</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
isolated from confirmed tests. Fifty-three of these were identified as Enterobacter cloacae, 22 as Citrobacter, 16 as Klebsiella pneumoniae, 13 as Enterobacter aerogenes, 1 as Enterobacter liquefaciens, and 1 as Serratia, and 11 strains were not identified. Strains of Citrobacter (intermediate types I and II) were isolated from 69% of samples which gave negative fecal tests and from 7% of samples which gave positive tests. Intermediate types appear to constitute a considerable proportion of the coliforms in unpolluted soils and in water flowing through such soils (4). In addition, E. cloacae and possibly Citrobacter appear to be part of the normal flora associated with vegetation (2, 8). The results indicate that approximately half of the coliforms isolated from the confirmed tests on the hides and meat may be of nonfecal origin.

E. coli was isolated from 94.4% of samples which gave positive fecal tests. Coliforms other than E. coli were isolated from 26 of the tests. Four of these were identified as E. cloacae, 5 as Citrobacter, 5 as E. aerogenes, 10 as K. pneumoniae, and 2 strains were not identified. Six strains (one E. cloacae, one E. aerogenes and four K. pneumoniae) gave positive reactions when retested in pure culture in the fecal test. Five occurred with E. coli in the original test, and only one strain of K. pneumoniae appears to have been solely responsible for a positive test. Knittel (7) considered K. pneumoniae to be of fecal origin, and the test therefore appears to be a good indication of fecal coliforms.

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LITERATURE CITED