
Sydney M. Finegold, Howard R. Attebery and Vera L. Sutter

Colon and rectal cancer together account for an estimated 92,500 new cancer cases in the U.S. annually, more than any other organ site; large bowel cancer results in an estimated annual mortality of 47,400, being second only to lung cancer in this regard (1). The median survival time for colon cancer patients is only 2.2 years. Recent epidemiologic studies are of great interest since they offer prospects of preventing this very serious form of cancer. Japan is one of a number of countries with a low incidence of large bowel cancer. However, Japanese migrating to the U.S. and adopting the western diet develop this cancer with increased frequency, approaching that of native Americans (1).

Hill et al. (2) have postulated that intestinal bacteria may produce carcinogens from bile acids or other substrates and that differing incidences of colon cancer may depend at least partly on differences in bowel flora related to diet. Deoxycholic acid, itself, a product of intestinal bacterial action on a primary bile acid, is weakly carcinogenic and might be important considering the large amount of deoxycholic acid the bowel is exposed to over a period of many years. Clostridium paraputrificum may be of particular significance since this organism has been shown to carry out certain modifications of bile acids which might represent transformation of these compounds toward carcinogenic agents (3, 4). The diets consumed in areas with a high incidence of bowel cancer are high in fat and animal protein content. High-fat diets result in a high fecal concentration of bile acids, thus providing more substrate for conversion to carcinogens. Studies comparing feces of subjects from Scotland, England, and the United States (high bowel cancer incidence) with that from subjects of India, Japan, and Uganda (low incidence of bowel cancer) reveal that in the subjects from countries of high cancer incidence there was a higher concentration of fecal acidic steroids, that a greater percentage of these steroids were present in degraded form, and that intestinal bacteria recovered exhibited a much greater TABLE 1

<table>
<thead>
<tr>
<th>Background data on study subjects</th>
<th>Japanese dietb</th>
<th>Western dietb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nativity:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Issei</td>
<td>13 (17)</td>
<td>3 (4)</td>
</tr>
<tr>
<td>Nisei</td>
<td>2 (3)</td>
<td>9 (10)</td>
</tr>
<tr>
<td>Sansei</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Age:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>28–86</td>
<td>18–83</td>
</tr>
<tr>
<td>Mean</td>
<td>60.3</td>
<td>41.3</td>
</tr>
<tr>
<td>Sex:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Female</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Bowel movements/day</td>
<td>11/14 had 1 BM/dayc</td>
<td>16/18 had 1 BM/day or less</td>
</tr>
</tbody>
</table>

15 subjects; 20 specimens. b18 subjects; 20 specimens. aOne subject died; information not obtained. Figures in parentheses = number of specimens.

TABLE 2

<table>
<thead>
<tr>
<th>Dietary pattern of study subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Japanese meals/week</td>
</tr>
<tr>
<td>14</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>0.5</td>
</tr>
<tr>
<td>18 (20)</td>
</tr>
</tbody>
</table>

Figures in parentheses = number of specimens.

1 From Medical Service and Anaerobic Bacteriology Laboratory, Wadsworth Hospital Center, Veterans Administration, Department of Medicine, UCLA School of Medicine and Department of Pediatric Dentistry, UCLA School of Dentistry, Los Angeles, California.

2 Supported in part by Public Health Service Contract NIH NCI-E-72-3209.
capacity for degrading steroids (5). Furthermore, there is evidence that colonic neoplasia begins on the surface of the bowel in response to an exogenous stimulus (6).

Breast cancer incidence is closely correlated with that of bowel cancer. Intestinal bacteria produce estrogens from steroid substrates in the colon (5). Thus diet, bowel flora, and breast cancer may also be interrelated.

Drasar and Hill (5) point out that intestinal bacteria might be involved in carcinogenesis without the mediation of carcinogen production—through an effect on the immune system or by other mechanisms.

The present study was designed to explore further the effect of diet on fecal flora. Two groups of Japanese ancestry living in Los Angeles, one eating primarily the traditional Japanese diet and the other primarily an American diet, were compared.

**Methods**

Thirty-three Japanese-American subjects volunteered for these studies. Most of the 15 subjects who

## TABLE 3
Media used for stool cultures

**For Aerobic Incubation**

<table>
<thead>
<tr>
<th>Media</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood agar plate</td>
<td></td>
</tr>
<tr>
<td>Blood agar plate (heated dils.)</td>
<td></td>
</tr>
<tr>
<td>Deoxycholate agar</td>
<td></td>
</tr>
<tr>
<td>Nitrogen-deficient agar</td>
<td></td>
</tr>
<tr>
<td>Cetrimide agar</td>
<td></td>
</tr>
<tr>
<td>Polymyxin staphylococcus agar</td>
<td></td>
</tr>
<tr>
<td>Pfizer selective enterococcus agar</td>
<td></td>
</tr>
<tr>
<td>Molybdate agar</td>
<td></td>
</tr>
<tr>
<td>Sabouraud’s agar with chloramphenicol</td>
<td></td>
</tr>
<tr>
<td>Tryptose-phosphate broth-agar with rabbit serum</td>
<td></td>
</tr>
</tbody>
</table>

**For Anaerobic Incubation**

<table>
<thead>
<tr>
<th>Media</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood agar plate</td>
<td></td>
</tr>
<tr>
<td>Blood agar plate (heated dils.)</td>
<td></td>
</tr>
<tr>
<td>Medium no. 10 (Bryant)</td>
<td></td>
</tr>
<tr>
<td>RGCA (Rumen glucose cellobiose agar)</td>
<td></td>
</tr>
<tr>
<td>WAL All Purpose Medium (APM) - PRAS</td>
<td></td>
</tr>
<tr>
<td>Egg yolk agar plate (heated dils.)</td>
<td></td>
</tr>
<tr>
<td>Neomycin-Nagler egg yolk agar</td>
<td></td>
</tr>
<tr>
<td>Kanamycin-vancomycin (KV) blood agar</td>
<td></td>
</tr>
<tr>
<td>KV laked blood agar</td>
<td></td>
</tr>
<tr>
<td>Tomato juice - Eugonagar (Bifidobacterium medium)</td>
<td></td>
</tr>
<tr>
<td>LBS (Lactobacillus selective) medium</td>
<td></td>
</tr>
<tr>
<td>Rifampin blood agar</td>
<td></td>
</tr>
<tr>
<td>Rifampin-vancomycin blood agar</td>
<td></td>
</tr>
<tr>
<td>Veillonella-neomycin agar</td>
<td></td>
</tr>
<tr>
<td>Closed roll tube - high H₂ concn.</td>
<td></td>
</tr>
<tr>
<td>Mitis-salivarius agar (aerobic incub. subseq.)</td>
<td></td>
</tr>
<tr>
<td>Anaerobic spirochete medium (VPI)</td>
<td></td>
</tr>
<tr>
<td>Anaerobic Sarcina medium (Drasar)</td>
<td></td>
</tr>
<tr>
<td>Fusobacterium selective medium (Ueno)</td>
<td></td>
</tr>
</tbody>
</table>

## TABLE 4
Characteristics of feces of Japanese on different diets

<table>
<thead>
<tr>
<th></th>
<th>Japanese diet&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Western diet&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specimen weight, g</td>
<td>55 (9–188)</td>
<td>77 (13–211)</td>
</tr>
<tr>
<td>Percent solids</td>
<td>28 (7.9–50.0)</td>
<td>22 (12.7–34.2)</td>
</tr>
<tr>
<td>pH</td>
<td>6.8 (6.0–7.9)</td>
<td>6.8 (5.7–7.7)</td>
</tr>
<tr>
<td>Microscopic count (× 10¹⁰/g dry weight)</td>
<td>7.6 (3.0–22)</td>
<td>8.3 (1.0–22)</td>
</tr>
<tr>
<td>Anaerobic count (× 10¹⁰/g dry weight)</td>
<td>2.5 (0.1–11)</td>
<td>3.3 (1.1–6.8)</td>
</tr>
<tr>
<td>Aerobic count (× 10⁸/g dry weight)</td>
<td>6.7 (0.03–38)</td>
<td>3.9 (0.02–20)</td>
</tr>
<tr>
<td>Number of specimens with EOS bacteria</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>Specimens with spirochetes present microscopically</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>% Specimens with methane bacteria present</td>
<td>40</td>
<td>40</td>
</tr>
</tbody>
</table>

<sup>a</sup> 15 subjects. <sup>b</sup> 18 subjects. Figures in parentheses represent the range.
subsisted primarily on a Japanese diet were residents of a nursing home who were well enough to give a good dietary history and to cooperate with the procedure required for stool collection. Major dietary items consumed by this latter group included rice, bean curds (tofu), udon (noodles), miso (soybean) soup, Japanese white radishes, pickled radish, Chinese cabbage and cucumbers, raw fish (sashimi), salted dried fish, seaweed (nori), bean sprouts and green tea. Most subjects used soy sauce on the Western food they consumed. These 15 subjects ranged in age from 28 to 86. Eighteen subjects eating a primarily western diet were also studied; the age of these subjects ranged from 18 to 83 years. Sex distribution was comparable in the two groups. None of the subjects had active gastrointestinal disease. None had been on antimicrobial agents of any kind within 2 weeks of the sample collection date. None of these subjects had required laxatives or enemas within the week prior to stool collection. Background data on participating subjects are presented in Table 1 and the number of Japanese meals consumed weekly is noted in Table 2.

The stool specimens were collected at the nursing home or the subjects’ residences in a sterile glass jar and promptly placed into an anaerobic jar. An evacuation-replacement technique utilizing 90% N2 and 10% H2 was used to create anaerobic conditions. A paraffin insert was used to eliminate half of the

FIG. 1. Predominant human fecal flora for Japanese diet, 20 specimens from 15 subjects. The length of the block represents the range; vertical line within the block represents the median count of the organism in those specimens harboring the organism.

FIG. 2. Predominant human fecal flora for western diet, 20 specimens from 18 subjects. The length of the blocks represents the range; vertical line within the block represents the median count of the organism in those specimens harboring the organism.

TABLE 5
Facultative or aerobic gram-negative bacilli

<table>
<thead>
<tr>
<th>In Japanese diet</th>
<th>Western diet</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number specimens harboring</strong></td>
<td><strong>Range</strong></td>
</tr>
<tr>
<td>Arizona sp.</td>
<td>1</td>
</tr>
<tr>
<td>Citrobacter freundii</td>
<td>1</td>
</tr>
<tr>
<td>Citrobacter sp.</td>
<td>4</td>
</tr>
<tr>
<td>Enterobacter cloacae</td>
<td>1</td>
</tr>
<tr>
<td>Enterobacter hafniae</td>
<td>1</td>
</tr>
<tr>
<td>Enterobacter liquefaciens</td>
<td>6</td>
</tr>
<tr>
<td>Enterobacter sp.</td>
<td>0</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>20</td>
</tr>
<tr>
<td>E. coli, lactose-negative</td>
<td>1</td>
</tr>
<tr>
<td>Klebsiella ozaenae</td>
<td>0</td>
</tr>
<tr>
<td>Klebsiella pneumoniae</td>
<td>3</td>
</tr>
<tr>
<td>Klebsiella species</td>
<td>8</td>
</tr>
<tr>
<td>Proteus mirabilis</td>
<td>3</td>
</tr>
<tr>
<td>Proteus morganii</td>
<td>1</td>
</tr>
<tr>
<td>Proteus retgeri</td>
<td>0</td>
</tr>
<tr>
<td>Proteus vulgaris</td>
<td>0</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>4</td>
</tr>
</tbody>
</table>

Total 9.12 9.01

a Log10 no. organisms/gram (rounded off to nearest log in the case of range).
### Table 6
Facultative Streptococci

<table>
<thead>
<tr>
<th></th>
<th>Japanese diet</th>
<th>Western diet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number specimens harboring</td>
<td>Range</td>
</tr>
<tr>
<td><strong>Enterococcus group</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>S. faecalis var. faecalis</em></td>
<td>14</td>
<td>4-10</td>
</tr>
<tr>
<td><em>S. faecalis var. liquefaciens</em></td>
<td>5</td>
<td>3-8</td>
</tr>
<tr>
<td><em>S. faecalis var. zymogenes</em></td>
<td>3</td>
<td>7-10</td>
</tr>
<tr>
<td><em>S. faecium</em></td>
<td>5</td>
<td>6-10</td>
</tr>
<tr>
<td><em>S. faecium var. castiflauus?</em></td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td><em>S. durans</em></td>
<td>2</td>
<td>5-8</td>
</tr>
<tr>
<td><strong>Other Group D Streptococci</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>S. bovis</em></td>
<td>5</td>
<td>4-11</td>
</tr>
<tr>
<td><em>S. equinus?</em></td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td><strong>Other Streptococci</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>S. agalactiae</em></td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><em>S. cremoris</em></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><em>S. equisimilis</em></td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><em>S. lactis</em></td>
<td>2</td>
<td>4-10</td>
</tr>
<tr>
<td><em>S. mitis</em></td>
<td>3</td>
<td>6-7</td>
</tr>
<tr>
<td><em>S. MG</em></td>
<td>2</td>
<td>4-8</td>
</tr>
<tr>
<td><em>S. pyogenes</em></td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td><em>S. salivarius</em></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><em>S. sanguis</em></td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><em>S. thermophilus?</em></td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td><em>S. uoberis</em></td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td><em>S. zooepidemicus?</em></td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>13</td>
<td>4-11</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Log_{10} no. organisms/gram (rounded off to nearest log in the case of range).*

### Table 7
Other facultative or aerobic organisms

<table>
<thead>
<tr>
<th></th>
<th>Japanese diet</th>
<th>Western diet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number specimens harboring</td>
<td>Range</td>
</tr>
<tr>
<td><strong>Sarcina lutea</strong></td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>Sarcina species</strong></td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td><strong>Pediococcus species</strong></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Micrococcus species</strong></td>
<td>3</td>
<td>4-9</td>
</tr>
<tr>
<td><strong>Staphylococcus epidermidis</strong></td>
<td>3</td>
<td>3-10</td>
</tr>
<tr>
<td><strong>Staphylococcus aureus</strong></td>
<td>2</td>
<td>4-7</td>
</tr>
<tr>
<td><strong>Bacillus species</strong></td>
<td>16</td>
<td>4-10</td>
</tr>
<tr>
<td><strong>Nocardia species</strong></td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td><strong>Candida albicans</strong></td>
<td>8</td>
<td>3-9</td>
</tr>
<tr>
<td><strong>Candida species</strong></td>
<td>2</td>
<td>4-9</td>
</tr>
<tr>
<td><strong>Other yeasts</strong></td>
<td>12</td>
<td>4-8</td>
</tr>
<tr>
<td><strong>Filamentous fungi</strong></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Log_{10} no. organisms/gram (rounded off to nearest log in the case of range).*
atmosphere of the anaerobic jar so that anaerobic conditions would be achieved more quickly. These specimens were then promptly transported (maximum distance of 15 miles) to our laboratory where they were then placed into an anaerobic chamber. The stool specimens were weighed inside the chamber and were then thoroughly homogenized, using Waring blender cups (sterile) of various sizes. Then an aliquot of approximately 1 g (exact weight determined subsequently) was obtained. Serial tenfold dilutions were prepared using APM diluent (7) with glass beads and mechanical agitation to effect good mixing. These dilutions were kept in an ice water bath in the chamber during subsequent processing.

The media used for culture are listed in Table 3. Direct microscopic counts were performed on suitable dilution blanks. The techniques for inoculation and incubation of media, for determinations of pH, of percent solids, and of extremely oxygen-sensitive (EOS) anaerobes, and the techniques for subsequent examination and identification of cultures are given elsewhere (7–9).

Second specimens were obtained from seven subjects (five on the Japanese diet and two on the western diet) after intervals of 2 to 19 weeks. Thus, a total of 20 specimens was studied for each of the two diet groups. The bacteriologists were not aware of the types of diets of the study subjects, nor were they aware of the fact that second specimens were obtained on some of the subjects.

Results

Background data (Table 1) reveal that the subjects in the two diet groups are comparable with regard to sex distribution and the number of bowel movements per day. The nature of the dietary habits of Japanese-Americans, unfortunately, is such that Issei (an older group for the most part) are much more likely to consume a more traditional Japanese diet whereas younger individuals of subsequent generations are more likely to eat a more nearly western diet. Thus, there was an unavoidable difference in age and nativity. The age difference was statistically significant (P value 0.013).

Table 4 lists some general characteristics of the stool samples, according to diet group. None of the differences noted was significant statistically. Data on the predominant fecal flora are presented graphically in Fig. 1 for the Japanese diet and Fig. 2 for the western diet.

Details on the specific bacteria recovered, together with the number of specimens harboring a given organism, the range of counts and the mean count per gram dry weight of specimen are given, according to diet group, in Tables 5-15. The numbered species cannot be fit into any of the established species; these were grouped into apparently similar groups, with each distinct group being assigned a separate number. In the case of the facultative streptococci, the “other” category also includes unclassifiable strains but these were lumped together and do not necessarily represent 13 different species. Statistical analysis was based on the 15 and 18 patients in the two groups, rather than on the 20 specimens in each group. The species or groups showing statistically significant differences between diet groups are noted in Table 18, together with means and P values. The only other organisms or groups which showed differences related to diet which approached statistical significance were Bacteroides fragilis (P value 0.086) and the

### Table 8

<table>
<thead>
<tr>
<th>Species</th>
<th>Japanese diet</th>
<th>Western diet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number specimens harboring</td>
<td>Range</td>
</tr>
<tr>
<td>L. acidophilus</td>
<td>5</td>
<td>6–10</td>
</tr>
<tr>
<td>L. fermentum</td>
<td>2</td>
<td>9–10</td>
</tr>
<tr>
<td>L. plantarum</td>
<td>2</td>
<td>7–10</td>
</tr>
<tr>
<td>L. minutus</td>
<td>0</td>
<td>9–10</td>
</tr>
<tr>
<td>L. species</td>
<td>3</td>
<td>5–10</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a Some were strict anaerobes. b Log_10 no. organisms/gram (rounded off to nearest log in the case of range).
### Table 9: Anaerobic cocci

<table>
<thead>
<tr>
<th>Anaerobic cocci</th>
<th>Japanese diet</th>
<th>Western diet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number specimens harboring</td>
<td>Range&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>EFFECT ON DIET ON HUMAN FECAL FLORA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Acidaminococcus fermentans</em></td>
<td>3</td>
<td>4–7</td>
</tr>
<tr>
<td><em>Megasphaera elsdonii</em></td>
<td>2</td>
<td>8–10</td>
</tr>
<tr>
<td><em>Peptococcus asaccharolyticus</em></td>
<td>3</td>
<td>7–9</td>
</tr>
<tr>
<td><em>Peptococcus magnus</em></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><em>Peptococcus prevotii</em></td>
<td>4</td>
<td>4–10</td>
</tr>
<tr>
<td><em>Peptococcus sp. 1</em></td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td><em>Peptococcus sp. 2</em></td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><em>Peptococcus sp. 3</em></td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td><em>Peptococcus sp. 4</em></td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td><em>Peptococcus sp. 5</em></td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td><em>Peptococcus sp. 6</em></td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td><em>Peptococcus sp. 7</em></td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td><em>Peptococcus sp. 8</em></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><em>Peptostreptococcus intermedius</em></td>
<td>10</td>
<td>8–10</td>
</tr>
<tr>
<td><em>Peptostreptococcus micros</em></td>
<td>2</td>
<td>8–9</td>
</tr>
<tr>
<td><em>Peptostreptococcus parvulus</em></td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td><em>Peptostreptococcus productus</em></td>
<td>7</td>
<td>7–10</td>
</tr>
<tr>
<td><em>P. c. c. sp.</em></td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>9–10</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>1</td>
</tr>
<tr>
<td><em>Sarcina sp. 1</em></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><em>Ruminococcus albus</em></td>
<td>3</td>
<td>9–10</td>
</tr>
<tr>
<td><em>Ruminococcus bromii</em></td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td><em>Ruminococcus flavefaciens</em></td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td><em>Ruminococcus sp. 1</em></td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td><em>Veillonella alcalescens</em></td>
<td>2</td>
<td>7–10</td>
</tr>
<tr>
<td><em>Veillonella parvula</em></td>
<td>6</td>
<td>3–10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Log<sub>10</sub> no. organisms/gram (rounded off to nearest log in the case of range).
### TABLE 10
**Bacteroides**

<table>
<thead>
<tr>
<th>Species</th>
<th>Japanese diet</th>
<th>Western diet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number specimens harboring</td>
<td>Range</td>
</tr>
<tr>
<td>B. capillosus</td>
<td>2</td>
<td>9–10</td>
</tr>
<tr>
<td>B. clostridiiformis</td>
<td>2</td>
<td>5–9</td>
</tr>
<tr>
<td>B. clostridiiformis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. coagulans</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>B. fragilis</td>
<td>11</td>
<td>7–11</td>
</tr>
<tr>
<td>ss. distasonis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. fragilis</td>
<td>6</td>
<td>8–10</td>
</tr>
<tr>
<td>ss. fragilis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. fragilis</td>
<td>9</td>
<td>7–10</td>
</tr>
<tr>
<td>ss. ovatus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. fragilis</td>
<td>14</td>
<td>9–11</td>
</tr>
<tr>
<td>ss. thetaotaomicron</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. fragilis</td>
<td>10</td>
<td>8–11</td>
</tr>
<tr>
<td>ss. vulgatus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. fragilis</td>
<td>8</td>
<td>3–10</td>
</tr>
<tr>
<td>other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. melaninogenicus</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>ss. intermedius</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. oralis</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>B. pneumostines</td>
<td>2</td>
<td>5–9</td>
</tr>
<tr>
<td>B. putredinis</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>B. ruminicola</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>ss. brevis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. ruminicola</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>ss. ruminicola</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. sp. 1</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>B. sp. 2</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>B. sp. 3</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>B. sp. 4</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>B. sp. 5</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>B. sp. 6</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>B. sp. 7</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>B. sp. 8</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>B. sp. 9</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*a Log₁₀ no. organisms/gram (rounded off to nearest log in the case of range).

### TABLE 11
**Fusobacterium**

<table>
<thead>
<tr>
<th>Species</th>
<th>Japanese diet</th>
<th>Western diet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number specimens harboring</td>
<td>Range</td>
</tr>
<tr>
<td>F. gonidiaformans</td>
<td>4</td>
<td>5–6</td>
</tr>
<tr>
<td>F. russii</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>F. necrophorum</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>F. necrogenes</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>F. sp. 1</td>
<td>3</td>
<td>7–8</td>
</tr>
<tr>
<td>F. sp. 2</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>F. sp. 3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>F. sp. 4</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>F. sp. 5</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>F. sp. 6</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>F. sp. 7</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>5.02</td>
</tr>
</tbody>
</table>

*a Log₁₀ no. organisms/gram (rounded off to nearest log in the case of range).
<table>
<thead>
<tr>
<th>Eubacterium</th>
<th>Japanese diet</th>
<th>Western diet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number specimens harboring</td>
<td>Range$^a$</td>
</tr>
<tr>
<td><strong>E. aerofaciens</strong></td>
<td>8</td>
<td>6-11</td>
</tr>
<tr>
<td><strong>E. contortum</strong></td>
<td>5</td>
<td>7-10</td>
</tr>
<tr>
<td><strong>E. cylindroides</strong></td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td><strong>E. lentum</strong></td>
<td>16</td>
<td>5-10</td>
</tr>
<tr>
<td><strong>E. limosum</strong></td>
<td>2</td>
<td>5-9</td>
</tr>
<tr>
<td><strong>E. moniliforme</strong></td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td><strong>E. nitritogenes</strong></td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td><strong>E. rectale</strong></td>
<td>6</td>
<td>7-11</td>
</tr>
<tr>
<td><strong>E. tenue</strong></td>
<td>2</td>
<td>5-6</td>
</tr>
<tr>
<td><strong>E. tortuosum</strong></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>E. ventriosum</strong></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>E. sp. 1</strong></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>sp. 2</strong></td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td><strong>sp. 3</strong></td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td><strong>sp. 4</strong></td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td><strong>sp. 5</strong></td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td><strong>sp. 6</strong></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>sp. 7</strong></td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td><strong>sp. 8</strong></td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td><strong>sp. 9</strong></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>sp. 10</strong></td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td><strong>sp. 11</strong></td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td><strong>sp. 12</strong></td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td><strong>sp. 13</strong></td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td><strong>sp. 14</strong></td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td><strong>sp. 15</strong></td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td><strong>sp. 16</strong></td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td><strong>sp. 17</strong></td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td><strong>sp. 18</strong></td>
<td>2</td>
<td>9-10</td>
</tr>
<tr>
<td><strong>sp. 19</strong></td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td><strong>sp. 20</strong></td>
<td>2</td>
<td>9-11</td>
</tr>
<tr>
<td><strong>sp. 21</strong></td>
<td>2</td>
<td>4-6</td>
</tr>
<tr>
<td><strong>sp. 22</strong></td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td><strong>sp. 23</strong></td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td><strong>sp. 24</strong></td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td><strong>sp. 25</strong></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>sp. 26</strong></td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td><strong>sp. 27</strong></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>sp. 28</strong></td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td><strong>sp. 29</strong></td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td><strong>sp. 30</strong></td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td><strong>sp. 31</strong></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>sp. 32</strong></td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td><strong>sp. 33</strong></td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td><strong>sp. 34</strong></td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td><strong>sp. 35</strong></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>sp. 36</strong></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>sp. 37</strong></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>sp. 38</strong></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>sp. 39</strong></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>sp. 40</strong></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>sp. 41</strong></td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td><strong>sp. 42</strong></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>sp. 43</strong></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>sp. 44</strong></td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Total 10.46 10.10

$^a$ Log$_{10}$ no. organisms/gram (rounded off to nearest log in the case of range).
TABLE 13
Bifidobacterium

<table>
<thead>
<tr>
<th></th>
<th>Japanese diet</th>
<th>Western diet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number specimens harboring</td>
<td>Range</td>
</tr>
<tr>
<td>B. adolescentis A</td>
<td>3</td>
<td>8-9</td>
</tr>
<tr>
<td>B. adolescentis B</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>B. adolescentis C</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>B. adolescentis D</td>
<td>3</td>
<td>9-10</td>
</tr>
<tr>
<td>B. bifidum</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>B. breve</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>B. eikosanii</td>
<td>5</td>
<td>8-10</td>
</tr>
<tr>
<td>B. infantis ss. infantis</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>B. infantis ss. liberorum</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>B. infantis, other</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>B. longum ss. longum</td>
<td>2</td>
<td>8-9</td>
</tr>
<tr>
<td>B. thermophilum</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>B. sp. 1</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>B. sp. 2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>B. sp. 3</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>B. sp. 4</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>8.20</td>
</tr>
</tbody>
</table>

* Log no. organisms/gram (rounded off to nearest log in the case of range).

Bacteroides genus as a whole (P = 0.080). With regard to the facultative streptococci, when results are examined separately for all enterococci, for all Group D streptococci and for all non-Group D streptococci, there are no statistically significant differences.

Differences in C. paraputricum counts were not statistically significant. The relation of counts of this organism to the number of Japanese meals consumed per week is noted in Table 16; there were no significant trends. Other clostridia thought to be important in modifying bile acids so as to make them more likely to be carcinogenic, C. indolis and C. sartagoformum (Drasar and Hill, personal communication), were also studied in relation to diet—alone and together with C. paraputricum—and no significant trends were noted.

The results on the seven "duplicate" specimens are presented in Table 17; none of the differences noted was significant statistically. The biggest discrepancies between the two specimens from the same individuals occurred with the lactobacilli and Eubacterium (particularly E. lentum), groups for which there are no satisfactory selective media.

In all, over 220 distinct species, subspecies, or groups of bacteria were recovered from the subjects on the Japanese diet. The corresponding figure for those on the Western diet was over 160. Altogether, some 300 different types of organisms were encountered in the study. The 25 most prevalent species found in each diet group are listed in Table 19.

Discussion

Our approach to this study was to attempt a very thorough, detailed study of the entire fecal flora. Selective and differential media and media incorporating special substrates or atmospheric conditions were utilized in attempts to recover organisms which were not numerically dominant but which might still be important metabolically and to recover organisms with unique growth requirements. Our past experience with selective and differential media indicates that a number of isolates present in small numbers would be nonrecoverable without the use of such media. This type of definition of fecal flora might reveal significant differences between the two dietary groups. Subsequently, study of organisms present in significantly higher numbers in one diet group.
TABLE 14

Clostridium

<table>
<thead>
<tr>
<th>Species</th>
<th>Japanese diet</th>
<th>Western diet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number specimens harboring</td>
<td>Range</td>
</tr>
<tr>
<td>C. aminovalericum</td>
<td>3</td>
<td>6-8</td>
</tr>
<tr>
<td>C. barati</td>
<td>3</td>
<td>6-8</td>
</tr>
<tr>
<td>C. barkeri</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>C. bifermantans</td>
<td>4</td>
<td>4-8</td>
</tr>
<tr>
<td>C. botulinum BEF</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>C. cochlearatum</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>C. difficile</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>C. fallax</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>C. felsineum</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>C. ghoni</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>C. glycolicum</td>
<td>4</td>
<td>6-8</td>
</tr>
<tr>
<td>C. indolis</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>C. innocuum</td>
<td>7</td>
<td>5-11</td>
</tr>
<tr>
<td>C. inulimum</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>C. irregularis</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>C. malenomatum</td>
<td>2</td>
<td>4-5</td>
</tr>
<tr>
<td>C. oroticum</td>
<td>2</td>
<td>7-10</td>
</tr>
<tr>
<td>C. paraputrificum</td>
<td>5</td>
<td>8-9</td>
</tr>
<tr>
<td>C. perfringens</td>
<td>16</td>
<td>4-10</td>
</tr>
<tr>
<td>C. pseudotetanicum</td>
<td>2</td>
<td>5-7</td>
</tr>
<tr>
<td>C. putrefaciens 'B'</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>C. ramosum</td>
<td>14</td>
<td>7-10</td>
</tr>
<tr>
<td>C. sartagoformum</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>C. septicum</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>C. sordellii</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>C. sphenoides</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>C. sporosphaeroides</td>
<td>3</td>
<td>4-10</td>
</tr>
<tr>
<td>C. sp. 1</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>1</td>
</tr>
</tbody>
</table>
TABLE 14. Continued

<table>
<thead>
<tr>
<th></th>
<th>Japanese diet</th>
<th>Western diet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number specimens harboring</td>
<td>Range (^a)</td>
</tr>
<tr>
<td>27</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>28</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>29</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>30</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>31</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>32</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>33</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>34</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>35</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>36</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>40</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>43</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>44</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>45</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>46</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>47</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>49</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>50</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>51</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>52</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>53</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>54</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>55</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) Log \(_10\) no. organisms/gram (rounded off to nearest log in the case of range)

TABLE 15

Propionibacterium

<table>
<thead>
<tr>
<th></th>
<th>Japanese diet</th>
<th>Western diet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number specimens harboring</td>
<td>Range (^a)</td>
</tr>
<tr>
<td>(P.) granulosum</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>(P.) species 1</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

\(^a\) Log \(_10\) no. organisms/gram (rounded off to nearest log in the case of range).

might reveal metabolic or other activity of importance in predisposing to or protecting from cancer. One important aspect of intestinal microbiology not covered in the present study is the bacterial flora intimately associated with the gastrointestinal mucosal epithelium (10, 11).

Extremely oxygen-sensitive (EOS) anaerobes were more commonly recovered on the Japanese diet (15/20 specimens) than on the west-
TABLE 16
Effect of diet on \textit{Clostridium paraputrificum} counts

<table>
<thead>
<tr>
<th>No. Japanese meals/week</th>
<th>No. Subj</th>
<th>No. positive for \textit{C. parapurtificum}</th>
<th>Counts of \textit{C. parapurtificum}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japanese diet</td>
<td>14</td>
<td>5</td>
<td>Range: 8-9, Mean: 9</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>1</td>
<td>Range: 8-9, Mean: 10</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>1</td>
<td>Range: 6-9, Mean: 7</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0</td>
<td>Range: 2-8, Mean: 5</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>Range: 2-8, Mean: 3</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>4</td>
<td>Range: 2-8, Mean: 3</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>1</td>
<td>Range: 2-8, Mean: 1</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Log\(_10\) no. organisms/gram (rounded off to nearest log).

TABLE 17
Comparison of duplicate specimens on 7 individuals\textsuperscript{a}

<table>
<thead>
<tr>
<th>No difference between 2 specimens</th>
<th>Present in one, but not in other specimen</th>
<th>Present in both specimens, but 4 log or more difference in count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coliforms</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Lactobacilli</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Streptococci</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Group D</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>\textit{B. fragilis}</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>\textit{B. putredinis}</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>\textit{B. pneumosintes}</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>\textit{Fusobacterium}</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>\textit{Megaspheara}</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>\textit{Veillonella}</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>\textit{P. magnus}</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>\textit{Peptostreptococcus}</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>\textit{Eub. contortum}</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>\textit{Eub. lentum}</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>\textit{Bif. adolescentis}</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>\textit{Bif. infantis}</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>\textit{Clostridium parapurtificum}</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Methane bacteria (culture only, 5 subj.)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>\textit{C. perfringens}</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>\textit{C. ramonosum}</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>\textit{C. innocuum}</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{a} 20 specimens from 15 subjects.  \textsuperscript{b} 20 specimens from 18 subjects.  \textsuperscript{c} Based on contingency table analysis (Fisher’s exact probability statistic).  \textsuperscript{d} Years (mean).  \textsuperscript{e} Confirmed by \textsuperscript{t}-test.  \textsuperscript{f} Mean count log\(_10\) no. organisms/gram feces.

Recovery of over 35\% of the direct microscopic count (by the Petroff-Haussler technique) is generally quite good. The recovery may actually have been better than indicated by this percentage, however. A relatively large number of fibers were noted microscopically in dilution tubes. Correction for the presence of these fibers would result in a higher recovery percentage. Furthermore, although it is clear that most bacteria seen on direct smear are alive, a certain number are undoubtedly dead. If there were a simple, convenient way to distinguish directly between live and dead organisms, correction for dead organisms would show that a greater percentage recovery was achieved.

Organisms recovered in this study but only seldom reported previously from human feces include \textit{Acidaminococcus fermentans} (7), \textit{Megasphaera elsdenii} (12), methane bacteria (13), anaerobic \textit{Sarcina} (14) and \textit{Ruminococcus} (15).

It is clear that diet may play a significant role in determining the bacterial content of the feces (16). For example, Americans have lower counts of \textit{Clostridium} in their stool than people living in Japan (17). Ueno and his colleagues (18) point out certain differences with regard to gram-negative anaerobic bacilli in people on the traditional Japanese diet and those on a western diet. \textit{Fusobacterium nucleatum} is typically absent in Japanese and may be present in Americans. Other fusobacteria (formerly classified in the genus \textit{Sphaerophorus}) are found...
more frequently and in higher counts in Japanese than in Americans (18, 19). Why this was not noted in the present study is unknown. An unclassifiable, very large, pleomorphic *Bacteroides* with pointed ends may be seen at times in stools of Americans but has not been noted in Japanese. The *Bacteroides* putredinis, recovered twice from western diet subjects in the current study, typically is seen more frequently in Americans than in Japanese. Finally, the high counts of *Escherichia coli* noted in the present study are typical for Japanese subjects (Ueno personal communication). However, there was no difference related to diet. One factor accounting for the high coliform counts was the fact that these organisms were often recovered in larger numbers of anaerobic plates than was true on aerobic plates. These organisms, although facultative, were apparently favored by the anaerobic conditions.

Previous studies of fecal flora in populations with high and low risk of developing bowel cancer have yielded somewhat divergent results, probably relating to relatively small numbers of people sampled. In the paper by Aries et al. (16), fecal samples from English people (high risk) were noted to contain significantly higher counts of *Bacteroides* and *Bifidobacterium* than specimens from Ugandans (low risk). A more recent paper from the same group (Hill et al. (2)) included a very large number of specimens (241 total) and compared British and American subjects (high cancer risk) with Ugandans, Indians, and Japanese (low cancer risk). The high risk population yielded many more *Bacteroides* whereas the low risk group had many more aerobic streptococci and enterobacteria. Furthermore, in the feces from Indians, only 22% of the enterococci were *S. faecalis*, whereas in the English, 64% of the enterococci were *S. faecalis*. Our results are somewhat different although we studied a much smaller number of specimens. We found significantly higher counts of *S. faecalis* var. *faecalis* in subjects on the Japanese diet. We did find higher counts of *Bacteroides*, and of *B. fragilis*.
specifically, in subjects on the western diet but the differences were not significant statistically. We also found significantly higher counts of certain facultative or aerobic organisms (but not enterobacteria) and of certain Gram-positive non-sporing anaerobic bacilli (Eubacterium contortum and E. lentum) and of certain Peptostreptococcus species in subjects on the Japanese diet. A Bifidobacterium infantis sub-sppecies was more prevalent on the western diet. Additional studies are certainly indicated to further explore the fascinating interrelationships between diet, intestinal bacterial and bowel cancer.

Addendum

Clostridium paraputificum, C. innocuum and C. butyricum are very similar. Review of the strains isolated in this study, in comparison with the reference strains (ATCC collection) revealed some errors in the initial classification. The correct data are as follows: C. innocuum was isolated from ten specimens in the Japanese diet group (counts $10^6$ to $10^9$/g) and from none in the western diet groups (counts $10^3$ to $10^5$/g). C. paraputificum was found in one Japanese diet group specimen ($10^7$/g) and in two western diet group specimens ($10^5$ to $10^7$/g). Table 16 is obviously in error as well.

We would like to acknowledge the excellent technical assistance of Palma Wideman, Walker Carter, Michel DeMeo and Paul Sugihara. Computing assistance was obtained from the Health Sciences Computing facility, UCLA, sponsored by NIH Special Research Resources Grant RR-3. We wish to thank Dr. Robert Mah of the UCLA School of Public Health for his assistance in the studies relating to methane bacteria, Drs. D. Austin and J. Dunn of the California State Department of Health made helpful suggestions regarding the analysis of data from this study. Mrs. Nellie Mitani, working for the California State Department of Health, did detailed dietary surveys on all subjects. Mrs. Kimi Ishii was very helpful in arranging for volunteers for participation in the study.

References