4-30-1987

Parasites of the cutthroat trout, *Salmo clarki*, and longnose suckers, *Catostomus catostomus*, from Yellowstone Lake, Wyoming

R. A. Heckmann  
*Brigham Young University*

H. L. Ching  
*Hydra Enterprises LTD, Vancouver, British Columbia, Canada*

Follow this and additional works at: [https://scholarsarchive.byu.edu/gbn](https://scholarsarchive.byu.edu/gbn)

**Recommended Citation**  
Available at: [https://scholarsarchive.byu.edu/gbn/vol47/iss2/11](https://scholarsarchive.byu.edu/gbn/vol47/iss2/11)

This Article is brought to you for free and open access by the Western North American Naturalist Publications at BYU ScholarsArchive. It has been accepted for inclusion in Great Basin Naturalist by an authorized editor of BYU ScholarsArchive. For more information, please contact scholarsarchive@byu.edu, ellen_amatangelo@byu.edu.
PARASITES OF THE CUTTHROAT TROUT, SALMO CLARKI, AND LONGNOSE SUCKERS, CATOSTOMUS CATOSTOMUS, FROM YELLOWSTONE LAKE, WYOMING

R. A. Heckmann¹ and H. L. Ching²

ABSTRACT.—Twenty-five cutthroat trout (Salmo clarki) and eight longnose suckers (Catostomus catostomus) from Yellowstone Lake, Wyoming, were collected and examined for parasites in 1985. Cutthroat trout had at least six different species of parasites that included both protozoans and helminths. The greatest number of parasite species on one fish was nine. Parasites added to the known list for cutthroat trout from Yellowstone Lake, Wyoming, were: Myxosoma sp., Diphyllobothrium ditremum, Diphyllobothrium dendriticum, Diplostomum baeri, and Posthodiplostomum minimum. These data were compared with a previous survey (1971) and a checklist of parasites of cutthroat trout in North America. There are 17 species of parasites and two fungal species reported for cutthroat trout from Yellowstone Lake. Trichophyta catostomi, Diplostomum spatheaeum, and Ligula sp. were observed in the small sample of longnose suckers.

Linton (1891a, 1891b) Woodbury (1932), and Bangham (1951) gave lists of parasites for Yellowstone Lake fishes, while Scott (1932, 1935, 1955), Simon (1935), and Cope (1958) published short reports concerning some of the known fish parasites from this lake. There is little information on the protozoan parasites from this locality. For instance, Bangham (1951) reported on one myxosporean from 2 of 291 cutthroat trout. Since the last comprehensive survey of parasites for a species of fish in Yellowstone Lake (Heckmann 1971), there have been brief reports on specific parasites. These articles emphasized the biology and host-parasite relationships of symbionts in the ichthyofauna of Yellowstone Lake (Otto and Heckmann 1984, Heckmann and Carroll 1985).

The scientific name currently used for the plerocercoids from cutthroat trout, Yellowstone National Park, is Diphyllobothrium cordiceps (Leidy 1871). Researchers in Canada and Norway have questioned the identification of the plerocercoids (Ching and Andersen, personal communication). There is a possibility of more than one type of plerocercoid in cutthroat trout, and there is the need to reevaluate the plerocercoids found in cutthroat trout from Yellowstone Lake.

The plerocercoids of Diphyllobothrium in Yellowstone Lake have received sporadic study since the early 1870s. Some of the natural hosts have been delineated. Prevalence and intensity in the second intermediate hosts (fishes) and natural definitive hosts (pelicans, gulls, and bears) have been determined by various researchers (Post 1971, Heckmann 1971). Life cycle experiments were completed using second intermediate hosts and natural definitive hosts as well as experimental hosts (dogs and domestic cats). Ova produced from the infected experimental hosts did not hatch. The first intermediate host for the cestode remains unidentified. Several aquatic zooplanktonic species in Yellowstone Lake are strongly suspected to be hosts in the life cycle.


¹Department of Zoology, Brigham Young University, Provo, Utah 84602.
²Hydra Enterprises Ltd., Box 2184, Vancouver, British Columbia, V6R 3V7, Canada
Table 1. Results of the 1985 survey for parasites of 25 cutthroat trout (*Salmo clarki*) from Yellowstone Lake, Yellowstone National Park, Wyoming.

<table>
<thead>
<tr>
<th>Fish number</th>
<th>Total length (mm)</th>
<th>Weight (grams)</th>
<th>Tricophyra</th>
<th>Copepods</th>
<th>Diplostomum* (metacercariae)</th>
<th>Plerocercoids**</th>
<th>Crepidostomum</th>
<th>Bulbacoenurus</th>
<th>Comments (other parasites)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>400</td>
<td>250</td>
<td>+++</td>
<td>+</td>
<td>(+ Retina, 11)</td>
<td>+ (S + L)</td>
<td>+</td>
<td>+</td>
<td>Two plerocercoid sizes</td>
</tr>
<tr>
<td>2</td>
<td>350</td>
<td>390</td>
<td>++</td>
<td>+</td>
<td>(+ Retina, 59)</td>
<td>+ (S)</td>
<td>+</td>
<td>+</td>
<td>Cestodes</td>
</tr>
<tr>
<td>3</td>
<td>345</td>
<td>450</td>
<td>++</td>
<td>+</td>
<td>(+ Retina, 15)</td>
<td>+ (L)</td>
<td>+</td>
<td>+</td>
<td>Leeches</td>
</tr>
<tr>
<td>4</td>
<td>355</td>
<td>525</td>
<td>+++</td>
<td>0</td>
<td>(+ Retina, 100+)</td>
<td>+ (S + L)</td>
<td>+</td>
<td>+</td>
<td>Cestodes in musculature</td>
</tr>
<tr>
<td>5</td>
<td>358</td>
<td>380</td>
<td>+++</td>
<td>+</td>
<td>(+ Retina, 28)</td>
<td>+ (S)</td>
<td>+</td>
<td>+</td>
<td>Cestodes in musculature</td>
</tr>
<tr>
<td>6</td>
<td>310</td>
<td>335</td>
<td>++</td>
<td>+</td>
<td>(+ Retina, 31)</td>
<td>+ (S)</td>
<td>+</td>
<td>+</td>
<td>Small cestodes only</td>
</tr>
<tr>
<td>7</td>
<td>329</td>
<td>410</td>
<td>++</td>
<td>+</td>
<td>(+ Retina, 18)</td>
<td>+ (S)</td>
<td>+</td>
<td>+</td>
<td>Small cestodes only, fungus</td>
</tr>
<tr>
<td>8</td>
<td>331</td>
<td>330</td>
<td>+++</td>
<td>0</td>
<td>(+ Retina, 21)</td>
<td>+ (S + L)</td>
<td>+</td>
<td>+</td>
<td>Plerocercoids frozen for electrophoresis Leeches</td>
</tr>
<tr>
<td>9</td>
<td>341</td>
<td>395</td>
<td>++</td>
<td>+</td>
<td>(+ Retina, 52)</td>
<td>+ (S + L)</td>
<td>+</td>
<td>+</td>
<td>Cestode in musculature</td>
</tr>
<tr>
<td>10</td>
<td>320</td>
<td>380</td>
<td>+++</td>
<td>+</td>
<td>(+ Retina, 41)</td>
<td>+ (S + L)</td>
<td>+</td>
<td>+</td>
<td>Myxospordias in gill tissue</td>
</tr>
<tr>
<td>11</td>
<td>330</td>
<td>400</td>
<td>++</td>
<td>+</td>
<td>(+ Retina, 34)</td>
<td>+ (S + L)</td>
<td>+</td>
<td>+</td>
<td>Cestodes in musculature</td>
</tr>
<tr>
<td>12</td>
<td>348</td>
<td>295</td>
<td>++</td>
<td>+</td>
<td>(+ Retina, 100+)</td>
<td>+ (S + L)</td>
<td>+</td>
<td>+</td>
<td>Cestodes in musculature</td>
</tr>
<tr>
<td>13</td>
<td>345</td>
<td>460</td>
<td>+++</td>
<td>+</td>
<td>(+ Retina, 100+)</td>
<td>+ (S + L)</td>
<td>+</td>
<td>+</td>
<td>Cestodes in musculature</td>
</tr>
<tr>
<td>14</td>
<td>260</td>
<td>320</td>
<td>++</td>
<td>+</td>
<td>(+ Retina, 18)</td>
<td>+ (S + L)</td>
<td>+</td>
<td>+</td>
<td>Cestodes in musculature</td>
</tr>
<tr>
<td>15</td>
<td>300</td>
<td>360</td>
<td>+++</td>
<td>+</td>
<td>(+ Retina, 100+)</td>
<td>+ (S + L)</td>
<td>+</td>
<td>+</td>
<td>Cestodes in musculature</td>
</tr>
<tr>
<td>16</td>
<td>305</td>
<td>355</td>
<td>++</td>
<td>+</td>
<td>(+ Retina, 50)</td>
<td>+ (S)</td>
<td>+</td>
<td>+</td>
<td>Small cestodes only</td>
</tr>
<tr>
<td>17</td>
<td>250</td>
<td>300</td>
<td>+++</td>
<td>0</td>
<td>(+ Retina, 21)</td>
<td>+ (S + L)</td>
<td>+</td>
<td>+</td>
<td>Leeches</td>
</tr>
<tr>
<td>18</td>
<td>300</td>
<td>345</td>
<td>++</td>
<td>+</td>
<td>(+ Retina, 36)</td>
<td>+ (S)</td>
<td>+</td>
<td>+</td>
<td>Small cestodes only</td>
</tr>
<tr>
<td>19</td>
<td>320</td>
<td>360</td>
<td>++</td>
<td>+</td>
<td>(+ Retina, 58)</td>
<td>+ (S + L)</td>
<td>+</td>
<td>+</td>
<td>Cestodes in musculature</td>
</tr>
<tr>
<td>20</td>
<td>250</td>
<td>310</td>
<td>+++</td>
<td>0</td>
<td>(+ Retina, 100+)</td>
<td>+ (S + L)</td>
<td>+</td>
<td>+</td>
<td>Leeches</td>
</tr>
<tr>
<td>21</td>
<td>275</td>
<td>315</td>
<td>++</td>
<td>+</td>
<td>(+ Retina, 17)</td>
<td>+ (S + L)</td>
<td>+</td>
<td>+</td>
<td>Fungus, Leeches</td>
</tr>
<tr>
<td>22</td>
<td>400</td>
<td>475</td>
<td>++</td>
<td>+</td>
<td>(+ Retina, 100+)</td>
<td>+ (S)</td>
<td>+</td>
<td>+</td>
<td>Small cestodes only</td>
</tr>
<tr>
<td>23</td>
<td>200</td>
<td>265</td>
<td>+++</td>
<td>+</td>
<td>(+ Retina, 46)</td>
<td>+ (S + L)</td>
<td>+</td>
<td>+</td>
<td>Two cestode sizes</td>
</tr>
<tr>
<td>24</td>
<td>310</td>
<td>365</td>
<td>++</td>
<td>0</td>
<td>(+ Retina, 27)</td>
<td>+ (S + L)</td>
<td>+</td>
<td>+</td>
<td>Two cestode sizes</td>
</tr>
<tr>
<td>25</td>
<td>315</td>
<td>345</td>
<td>+++</td>
<td>+</td>
<td>(+ Retina, 100+)</td>
<td>+ (S + L)</td>
<td>+</td>
<td>+</td>
<td>Cestodes in musculature</td>
</tr>
</tbody>
</table>

* The retina form is *D. baeri*, average number per eye in parentheses.
** There are two, possibly three, species of plerocercoids for cutthroat trout.
† When over 100 metacercariae are present, 100+ is recorded.
‡ Indicates presence of parasite; the number of pluses gives indication of parasite burden.

<table>
<thead>
<tr>
<th>Parasite group</th>
<th>Parasite species</th>
<th>Location of parasite</th>
<th>Prevalence (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ciliophora</td>
<td>Trichophrya clarki</td>
<td>Gill surface</td>
<td>100</td>
</tr>
<tr>
<td>Myxozoa</td>
<td>Myxosoma sp.</td>
<td>Skin, gills</td>
<td>4</td>
</tr>
<tr>
<td>Cestoda: Tapeworms</td>
<td><em>Diphylobothrium diphyllobothrium</em></td>
<td>Muscle, viscera</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td><em>Diphylobothrium dendriticum</em></td>
<td>Muscle, viscera</td>
<td>100</td>
</tr>
<tr>
<td>Digenea: Flukes</td>
<td><em>Diplostomum baeri</em></td>
<td>Retina of eye</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td><em>Posthodiplostomum minimum</em></td>
<td>Viscera</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Crepidostomum faramas</td>
<td>Intestine, gall bladder</td>
<td>100</td>
</tr>
<tr>
<td>Nematoda: Roundworms</td>
<td>Bulbocanectis scotti</td>
<td>Intestine, pyloric caeca</td>
<td>100</td>
</tr>
<tr>
<td>Crustacea: Copepods</td>
<td>Salmincola sp.</td>
<td>Gills, mouth</td>
<td>80</td>
</tr>
<tr>
<td>Hirudinea: leeches</td>
<td>Piscicola salmostrae</td>
<td>Gills, fins</td>
<td>16</td>
</tr>
<tr>
<td>Fungi</td>
<td>Ichthyophonus sp.</td>
<td>Skin surface</td>
<td>8</td>
</tr>
</tbody>
</table>

*larval stages, plerocercoids and metacercariae

This project had two main goals: (a) to conduct a survey for parasites in two common species of fish in Yellowstone Lake, cutthroat trout (Salmo clarki) and longnose suckers (Catostomus catostomus) and (b) to identify the species of plerocercoids found in S. clarki. The other helminth parasites of Yellowstone Lake fishes will be reviewed.

**Materials and Methods**

Collections of cutthroat trout were obtained by net and trap at two sites on the east side of Yellowstone Lake during June 1985. Each fish was examined for external and internal parasites (immediately after death). The gills, fins, and viscera were removed and placed in finger bowls containing physiological saline. The organs were examined using a dissecting microscope. Each organ, the surface of each appendage, and the body surface were scraped with a scalpel, and the scrapings were placed in a depression slide containing a drop of physiological saline for examination using a compound microscope. Material from each scraping was also placed on glass slides, stained with methyl green-pyronin Y (Heckmann 1971), and observed at high magnification. Blood smears were prepared from the heart and peripheral circulatory system of each fish. Blood smears were air-dried, fixed with methyl alcohol, and stained with Giemsa. Each slide was examined with high dry (430X) and oil-immersion (1,000X) objectives for 10 minutes. Data for each fish included length, weight, sex, location of sample, and parasites and their organ sites. Plerocercoids from the fish were (a) fixed in buffered 3% gluteraldehyde and AFA (acetic acid, formalin, alcohol) while (b) other plerocercoids were frozen. Whole mounts as well as preparations for scanning electron microscopy were made of the plerocercoids. Fixed specimens were sent to Drs. H. Ching in Canada and K. Andersen in Norway for identifications. Attempts to infect gerbils with the plerocercoids were made but were not successful.

Infected tissues were fixed in 10% buffered formalin for histological preparations to help ascertain host-parasite interaction. Standard methods (Davenport 1960) were used in preparing fixed tissue for microscopic observations. Paraffin-embedded gills were sectioned at 4–6 μm. After the sections were fixed to glass slides, the tissue was stained with Harris hematoxylin and eosin and a pentachrome stain for observation with a compound light microscope.

Samples of plerocercoids fixed with buffered 3% gluteraldehyde were processed through standard techniques for scanning electron microscopy (Dawes 1971). After liquid dehydration each specimen was subjected to critical-point drying. After the specimen was mounted on a holder, each plerocercoid was coated with gold in a CS minicoater sputter apparatus and viewed with an AM Ray

<table>
<thead>
<tr>
<th>Par asite group</th>
<th>Parasite species</th>
<th>Location of parasite</th>
<th>Percent infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilopora:</td>
<td><em>Trichophrya clarki</em></td>
<td>Gills</td>
<td>95  100</td>
</tr>
<tr>
<td></td>
<td><em>Trichodina sp.</em></td>
<td>Gills</td>
<td>0.4  0</td>
</tr>
<tr>
<td>Myxozoa:</td>
<td><em>Myxosoma sp.</em></td>
<td>Skin, gills</td>
<td>0  4</td>
</tr>
<tr>
<td></td>
<td><em>Myxosporidan sp.</em></td>
<td>Gills</td>
<td>0.8  0</td>
</tr>
<tr>
<td>Flagellata:</td>
<td><em>Hacognegarina sp.</em></td>
<td>Blood cells</td>
<td>0.4  0</td>
</tr>
<tr>
<td></td>
<td><em>Costia pyriforis</em></td>
<td>Gills</td>
<td>19  0</td>
</tr>
<tr>
<td>Cestoda: Tapeworms</td>
<td><strong>Diphyllobothrium ditremum</strong></td>
<td>Muscle, viscera</td>
<td>0  100</td>
</tr>
<tr>
<td></td>
<td><strong>Diphyllobothrium dendriticum</strong></td>
<td>Muscle, viscera</td>
<td>0  100</td>
</tr>
<tr>
<td></td>
<td><strong>Diphyllobothrium sp.</strong></td>
<td>Muscle, viscera</td>
<td>92  0</td>
</tr>
<tr>
<td>Digenea: Flukes</td>
<td><strong>Diplostomum baeri buccalum</strong></td>
<td>Retina of eye</td>
<td>0  100</td>
</tr>
<tr>
<td></td>
<td><strong>Posthodiplostomum minimum</strong></td>
<td>Viscera</td>
<td>0  8</td>
</tr>
<tr>
<td></td>
<td><em>Crepidostomum farinosus</em></td>
<td>Intestine, gall bladder</td>
<td>95  100</td>
</tr>
<tr>
<td>Nematoda: Roundworms</td>
<td><em>Bulbodacnitis scotti</em></td>
<td>Intestine, pyloric caeca</td>
<td>95  100</td>
</tr>
<tr>
<td>Anacanthocephala: Spiny-headed worms</td>
<td><em>Neoechinorhynchus rutilii</em></td>
<td>Intestine</td>
<td>0.4  0</td>
</tr>
<tr>
<td>Crustacea: Copepods</td>
<td><em>Salmincola sp.</em></td>
<td>Gills, mouth</td>
<td>80  80</td>
</tr>
<tr>
<td>Hirudinea: leeches</td>
<td><em>Piscicola salmositica</em></td>
<td>Gills, fins</td>
<td>18  16</td>
</tr>
<tr>
<td></td>
<td><em>Illinoidea sp.</em></td>
<td>Fins</td>
<td>0.4  0</td>
</tr>
<tr>
<td>Fungi: Mycota</td>
<td><em>Ichthyophonus sp. (Saprolegnia)</em></td>
<td>Skin surface</td>
<td>0  8</td>
</tr>
</tbody>
</table>


**Larval stages, plerocercoids and metacercariae

Table 4. Results of the survey for parasites of eight longnose suckers (*Catostomus catostomus*) from Yellowstone Lake, Yellowstone National Park, Wyoming.

<table>
<thead>
<tr>
<th>Fish number</th>
<th>Total length (mm)</th>
<th>Weight (grams)</th>
<th><em>Trichophrya</em></th>
<th><em>Diplostomum</em></th>
<th><em>Ligula intestinalis</em></th>
<th>Comments (other parasites)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (male)</td>
<td>415</td>
<td>810</td>
<td>+</td>
<td>+ (Lens, 49)</td>
<td>1 (large)</td>
<td><em>Ligula</em> 13.5 x 420 mm (contracted, gonad compression and atrophy)</td>
</tr>
<tr>
<td>2 (male)</td>
<td>436</td>
<td>1250</td>
<td>+</td>
<td>+ (Lens, 100+)</td>
<td>(Retina, 5–10)</td>
<td>Both lens and retina metacercariae</td>
</tr>
<tr>
<td>3 (female)</td>
<td>360</td>
<td>600</td>
<td>+</td>
<td>+ (Lens, 100+)</td>
<td>—</td>
<td>Opaque lens metacercariae</td>
</tr>
<tr>
<td>4 (male)</td>
<td>432</td>
<td>1250</td>
<td>+</td>
<td>+ (Lens, 20)</td>
<td>—</td>
<td>Opaque lens center</td>
</tr>
<tr>
<td>5 (female)</td>
<td>310</td>
<td>400</td>
<td>+</td>
<td>+ (Lens, 20)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>6 (female)</td>
<td>412</td>
<td>800</td>
<td>+</td>
<td>+ (Lens, 39)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>7 (male)</td>
<td>440</td>
<td>950</td>
<td>+</td>
<td>+ (Lens, 10)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>8 (male)</td>
<td>420</td>
<td>815</td>
<td>+</td>
<td>+ (Lens, 35)</td>
<td>1 (large)</td>
<td><em>Ligula</em> large</td>
</tr>
</tbody>
</table>

*The lens form is *D. spathaceum*.

1000, a high-resolution scanning electron microscope operating at 20 KV. Micrographs were taken at variable magnifications up to 10,000X. Similar steps or magnifications were duplicated for each specimen. A digital data keyboard entry system was used to incorporate a permanent record on each micrograph. This record included the KV, magnification, micron bar, plate number, laboratory location, and specimen code number which was assigned to each plerocercoid.

Eight longnose suckers collected with the cutthroat trout were examined for parasites using the same methods of study.

RESULTS AND DISCUSSION

The results for the 1985 parasite survey for *Salmo clarki* found in Yellowstone Lake are listed in Tables 1 and 2. The cutthroat trout
ranged in total length from 200 to 400 mm and weighed from 250 to 525 grams.

In comparison with the previous survey (Heckmann 1971), three protozoan species and the spiny-headed worm, Neoechinothrynchus rutili, were not observed. These parasites were rarely present during the 1971 survey in which 250 fish were checked for parasites from 34 collection sites. Four parasites were added to the current list (Table 3) following the 1985 survey.

Cutthroat trout had at least six different species of parasites that included both protozoa and helminths (Table 3). The greatest number of different parasite species per fish observed was nine. Each parasite will be discussed separately and compared with a checklist of parasites for cutthroat trout in North America. One limitation of this study was the number of fish sampled representing only two sites on Yellowstone Lake.

For the eight longnose suckers, Catostomus catostomus, there were only three parasites observed (Table 4). These parasites are included in the discussion of cutthroat trout parasites.

**Trichophrya**

*Trichophrya* is a genus of suctorian ciliate that commonly infests the gill surface of fishes throughout the world. Their usual mode of reproduction is by endogenous buds.

*Trichophrya clarki* (Figs. 1a, 1b) (Heckmann 1970, Heckmann and Carroll 1985) was found on the gills of all cutthroat trout examined from two sites on Yellowstone Lake, Yellowstone National Park, Wyoming, during the summer of 1985. *Trichophrya catostomi* (Heckmann 1970, 1971) was present on the gills of 100% of the adult longnose suckers examined from the same region (Tables 1, 4).

Butschli (1889) reported *Trichophrya* in perch (Perca) and pike (Esox) from Europe and assigned the species name *T. piscium*. Davis (1937, 1942) was the first to report *Trichophrya* in the northern hemisphere. He assigned the names *T. micropteri* and *T. icitaluri* for the gill parasites of smallmouth black bass (Micropterus dolomieui) and channel catfish (*Ictalurus punctatus*), respectively. No name was given for *Trichophrya* in brook trout (*Salvelinus fontinalis*). He also was the first to suggest that it may have a pathogenic effect. Culbertson and Hull (1962) summarized all host records of *Trichophrya* and suggested *T. piscium* be used for all species found in fishes. This suggestion was followed by Sandeman and Pippy (1967), who reported on four salmonids of Newfoundland infested with *Trichophrya*. Hoffman (1967) stressed the need for further taxonomic study of trichophryan species and their symbiotic effects.

For our study, light microscopy disclosed extensive pathology and an average of 7.1% of the gill epithelium covered for longnose suckers due to *T. catostomi*. However, no damage was observed at the light level of magnification for *T. clarki* in cutthroat trout that had an equal area of the gill covered.

Electron micrographs (Heckmann and Carroll 1985) show damage to immediate host gill cells by both parasites, depicted by a reduction and lack of mitochondria. Both parasites form attachment helices (0.52 x 0.04 μm), which function for maintenance of parasite position on the host cell. Protozoan feeding on host tissue may be accomplished by use of necrotic gill tissue and mucus (Heckmann and Carroll 1985).

**Myxosoma**

During the 1985 survey one cutthroat trout had white cysts in the gills and skin that contained spores of a *Myxosoma* sp. Heckmann (1971) reported the presence of another myxosporean in the same sites.

Myxosporeans are diagnosed when the parasite is in the spore stage; opaque white cysts containing spores are visible on the fish. Histozoic species, such as those of *Myxosoma*, usually form large cysts that can be seen without magnification. The identification of the myxosporean is customarily based on the spore morphology. Each spore contains a single sporoplasm and one to four polar capsules with coiled filaments (Hoffman 1967).

The life cycle is direct, from fish to fish. This has been experimentally verified for *Myxidium*, *Chloromyxum*, and *Leptotheca*, but not for other genera. After ingestion, the sporoplasm leaves the spore, presumably penetrates the intestine, and migrates to the final site, which is often very specific for a given species. The sporoplasm grows into a trophozoite, the nuclei divide, and the structure usually grows to produce many spores in a cyst or in a single trophozoite. If the cyst is near the surface, it may rupture and the spores will
Fig. 1a, 1b. *Trichophrya clarki* (arrows) infesting the gills of *Salmo clarki*. Note the large macronucleus (n) and tentacles (t) characteristic of suctorian ciliates (400X).

be freed in the water. If the cysts are internal, the fish must die and disintegrate to free the spores (Hoffman 1967).

*Myxosoma* is characterized by an oval spore with two piriform polar capsules at the anterior end. The sporoplasm of the trophozoite does not contain an iodinophilous vacuole. Most of the known species are histozoic (Hoff-
The plerocercoid stages of *Diphyllobothrium* parasitize salmonid fishes of Yellowstone Lake, Wyoming, and other lakes in Yellowstone National Park. The parasites are found primarily in the cutthroat trout of Yellowstone Lake. *Diphyllobothrium* plerocercoids have been known in fishes of Yellowstone National Park since the first formal publication by Leidy (1872). Linton (1891b) gave the first description of adult cestodes taken from pelicans from the lake area.

In the current study, plerocercoids of *Diphyllobothrium* were present in all cutthroat trout examined from two locations on Yellowstone Lake.

Much confusion has evolved on the taxonomic relationship of *Diphyllobothrium* species (Otto and Heckmann 1984). In our study, two species of *Diphyllobothrium* plerocercoids were found: *D. ditremum* (Fig. 2) and *D. dendriticum* (Fig. 3), based on identifications by Ching and Andersen (personal communication) and Andersen (1977).

The life cycle of *Diphyllobothrium* species in Yellowstone cutthroat trout would be similar to the life cycles of other *Diphyllobothrium* species. A typical life cycle would be as follows: the egg, upon being deposited in the water, develops and hatches into a ciliated coracidium. The coracidium is then eaten by a crustacean host where it passes through the stomach wall and encysts in the tissues of the body cavity. The procercoid then develops within the crustacean. It remains within this host until the crustacean is eaten by a trout or other fish. The procercoid is then released upon ingestion and digestion of the crustacean. It migrates through the wall of the alimentary tract of the fish and develops into a plerocercoid.
The organism encysts in the cecal wall, mesentery, or other abdominal organs. The plerocercoid continues to grow until it can break from the cyst and become free in the abdominal cavity of the fish. The plerocercoid may then migrate into the flesh and become encapsulated. Instances of plerocercoids entering the muscle have been found where part of the plerocercoid remains in the body cavity and part is in the muscle. Plerocercoids are never encysted if they are in the body cavity or in the muscle tissue.

Plerocercoids of Diphyllobothrium are released from cysts or from muscle tissue of the fish when they are taken as food by the primary host. The plerocercoid then develops into an adult cestode within the intestine of the primary host which is multiple for cutthroat trout.

The primary hosts for the adult Diphyllobothrium in Yellowstone Lake are white pelicans (Pelicanus erythrorhynchos), California gulls (Larus californicus), and American mergansers (Mergus merganser americanus) (Otto and Heckmann 1984).

The definitive hosts feed on infected fishes containing the plerocercoids. Information on man as a definitive host for Diphyllobothrium continues to be published (Arh 1960, Margolis et al. 1973, Ohbayashi et al. 1977). Woodbury (1932) ingested eight small plerocercoids, some free and some encapsulated, in late summer of 1931. Fecal examinations were made through November, after which an anti-helminthic was taken in December. No evidence of infection was found. The experiment was repeated the next year. Six larger plerocercoids (20–70 mm in length) were ingested. Fecal examinations for Diphyllobothrium eggs were negative. Scott ingested plerocercoids from Yellowstone Lake trout at various times with negative results (Post 1971). However, Vik (personal communication 1985) ingested plerocercoids and passed adult worms, indicating that human infections are possible. Crosby (1970) found that plerocercoids from Yellowstone Lake cutthroat trout resulted in viable, egg-producing adults in experimentally fed dogs.

The physiological effect of the plerocer-
coids in the fish intermediate host were referred to by Linton (1891a). These fish were described as being "emaciated." Other authors stressed this point, and today one may see such fish within the park. Heckmann (1971) noted that one fish taken from the west side of Yellowstone Lake near West Thumb had more than 400 plerocercoids.

Nothing has been done to assess the effect of sublethal infections of this parasite on the fish from Yellowstone National Park, and quite heavy loads of plerocercoids may be carried by young, vigorous fish without harm. However, moderate loads of plerocercoids may be reducing the vitality of even the most vigorous fish (Post 1971).

Recently, Otto and Heckmann (1984) studied the histopathological effects of the plerocercoids on host fish in Yellowstone Lake. Eight cutthroat trout from the Yellowstone River and Yellowstone Lake were examined by histological technique and scanning electron microscopy to determine the response of host tissue to the presence of diphyllolothriid larvae. Intact plerocercoids were encapsulated with connective tissue that was infiltrated with lymphocytes and macrophages. Granulomatous tissue that was fibrotic was also present. Pancreatic tissue was displaced in infections associated with the alimentary tract. The liver showed general necrosis with edema, and the spleen demonstrated a reduction in cellularity and increased connective tissue. Testicular tissue compressed by an adjacent plerocercoid appeared to be in an otherwise normal stage of development. Necrotic myofibrils near encapsulated parasites were separated by edema and fatty infiltration. In general, Diphyllolothrium cordiceps did not appear to produce a serious debilitation of cutthroat trout (Otto and Heckmann 1984).

**Diplostomum:** Metacercariae, Flukes

*Diplostomum baeri bucculentum* (Fig. 4) and *D. spathaceum* (Fig. 5) are strigeid trematodes (Diplostomatidae) with a metacercarial stage that causes a disease known as diplostomatosis or eye fluke disease of fishes (Doss et al. 1963). Because of the circumglobal nature of diplostomatosis as well as the severe

---

Fig. 4. *Diplostomum baeri*, metacercariae (m) found in the retina (r) of *Salmo clarki* (400X).
effects upon fish, amphibian, reptilian, bird, and mammalian lenses, much literature relating to this trematode exists. Cutthroat trout from Yellowstone Lake had a 100% incidence of D. baeri, with some fish containing over 100 metacercariae per eye (Table 1).

Fish are the most common second intermediate hosts for Diplostomum; however, infections in amphibians, reptiles, and mammals have also been reported (Ferguson 1943). Once the cercariae have penetrated the second intermediate host, they lose their forked tails and migrate to the tissues of the eye where the metacercariae develop in 50–60 days (Erasmus 1958). Diplostomatosis can cause cataracts of the lens tissue, due to the presence of the metacercarial stage of this parasite. Visual acuity for infected fish can be slightly hampered or lost, depending on the number of worms present. In addition to visual loss, fish show retarded growth and a change in food habits. In older fish, chronic infections produced subacute inflammatory reactions in the vitreous involving heterophilis and eosinophils, and macrophages with ingested lens material have been observed (Dollfuss 1949, Heckmann 1983, Palmieri et al. 1976).

There are many possible techniques to pursue concerning the control of diplostomatosis. One that shows promise is biological control by the use of a hyperparasite, Nosema strigeoidea (Microspora). Hussey (1971) reported the above species to be host specific for hyperparasitizing sporocysts of Diplostomum spathaceum. Palmieri and Heckmann (1976) and Palmieri et al. (1976) substantiated Hussey’s work for eye fluke infections of fish in Utah.

Reviews of the complete life history for Diplostomum spathaceum and D. baeri are found in Palmieri et al. (1976), Ching (1985), Davies (1972), and Hoffman and Hundley (1957).

The pathological effects of Diplostomum metacercariae upon the fish host are many. Examination of those fish blinded with cataract and containing a heavy burden of larval metacercariae revealed stunted growth (length, girth, and weight), abnormal feeding behavior (lack of response to visual stimuli), and decreased vital acuity (Palmieri et al.
1976, Heckmann and Palmieri 1978). Ashton et al. (1969) reported that larvae migrate to the eye via vascular-venous channels; he demonstrated that the lens, vitreous, or cor-
tex of the eye may be substantially damaged. Ferguson (1943) reported that metacercariae
could develop in the lens of a variety of experimentally infected vertebrate hosts including
mammals. Thus, there is a potential human hazard for these parasites (Ashton et al. 1969).
Ching (1985) clarified the differences between the metacercariae of the two species of
Diplostomum reported for this study.

Posthodiplostomum
The metacercariae were found in the vis-
cera of only 8% of the examined cutthroat
tROUT, Salmo clarki. An excellent review for
this common fish parasite is found in Spall and
have been found in all visceral organs but
occur in abundance in the liver, spleen, kid-
neys, mesenteries, sinus venosus, heart, and
ovaries. Avault and Allison (1965) found that
the heart, liver, and kidneys contained ap-
approximately 79% of the total metacercariae in
bluegill (Lepomis macrochirus).

Early literature concerning the classifica-
tion of Posthodiplostomum minimum (Fig. 6)
has been reviewed by Miller (1954), Hoffman
(1958), Bedinger and Meade (1957), and Spall
and Summerfelt (1969b).

Metacercariae of the strigeid fluke, Posthodiplostomum minimum, the white
grub, are reported in many American hel-
minthological surveys of fishes. The metacer-
cariae, first reported over a century ago, occur
in abundance in many of the 100 species of
North American fishes (Hoffman 1967). They
are generally so numerous in the liver, kid-
ney, heart, and other viscera that many ob-
servers have considered them to be histo-
pathogenic. The pathogenicity of the larval
stage is usually due to compression or occlu-
sion of the vital organ.

The occurrence of numerous metacercariae
in visceral organs suggests deleterious effects
on the well-being of the host and implicates
Posthodiplostomum minimum as a cause of
mortality or morbidity to its host. Hunter
(1937, 1940) stated that death resulted if suf-
cient liver or other visceral tissue were de-
stroyed by the metacercariae. Wild fish, with several hundreds of encysted metacercariae in the liver, sinus venosus, heart, and kidneys, are often observed to suffer no obvious debilitating effects. Colley and Olsen (1963) found as many as 991 metacercariae per bluegill with metacercariae so dense as to be clumped en masse. Spall and Summerfelt (1969a) have observed 2,041 metacercariae in a bluegill from an Oklahoma reservoir.

Mortality has been observed in the laboratory following exposure of suitable host fish to high numbers of cercariae (Hunter 1937, Bedinger and Meade 1967). Host reactions following cercarial penetration include petechial hemorrhage at the site of invasion, followed by congestion of surrounding venules, local edema, and an aggregation of leucocytes at the point of entry, particularly the phagocytic elements (Spall and Summerfelt 1969b).

Nutrition of the metacercaria involves transport across the cuticule. Oral feeding is impossible because the esophagus does not begin development until 8 days after penetration and is not well developed until 17 days; intestinal caeca develop after 17 days (Spall and Summerfelt 1969b).

After encystment (19 days), mortality infrequently occurs. There is no experimental evidence to indicate mortality or other detrimental effects from the occurrence of encysted metacercariae (Spall and Summerfelt 1969b). Compression of vital organs, such as gonadal tissue, needs to be further considered for this parasite.

Crepidostomum: Flukes, Adult Stage

In the 1985 survey all cutthroat trout were infected with Crepidostomum farionis. In the 1969–1970 survey, which included many more fish, 95% of the Salmo clarki were infected with the fluke (Heckmann 1971). The genus Crepidostomum is characterized by an elongated-oval to subcylindrical body. The oral suckers are terminal, surrounded anterodorsally by a half-crown, six-head papillae. The esophagus is short or moderate and the ventral sucker is in the anterior half of body. Characteristics of the life cycle are: adult in fish; oculate xiphidiocercaria in sphaerid clams; metacercaria in aquatic insects, usually mayflies, or amphipod crustaceans (Hoffman 1967).

Recent reviews of this fluke include Dollfus (1949) and Doss et al. (1964), while Amin (1982) and Hopkins (1931a, 1931b, 1934) list keys to species.

In relating the pathogenicity of Crepidostomum farionis to its host, Heckmann (1971) reported adult flukes in fingerling Salmo clarki often occupying the lumen of the gall bladder.

Bulbodacnitis: Roundworm, Nematoda

A consistent member for the parasitofauna of Salmo clarki from Yellowstone Lake, Wyoming, was Bulbodacnitis. Most adult nematodes of fish live in the intestinal tract, as is the case for this roundworm. In contrast, larval roundworms of fish may be found in almost every organ, but they are common in the mesenteries, liver, and musculature.

The life cycle of Bulbodacnitis always involves an invertebrate for the first intermediate host and fish, via food chains, as the definitive host. Other nematodes use the fish as the second intermediate host and develop to adults in the intestinal tract of piscivorous fish, birds, and mammals (Hoffman 1967).

Bulbodacnitis scotti was found in all of the cutthroat trout in this survey. It was one of the parasites described by Bangham (1951) in his studies of the parasites of fishes from Yellowstone Lake.

Salmincola

In the Crustacea there are two groups: the subclass Branchiura (fish lice) and the subclass Copepoda, some of which resemble free-living copepods. Certain species, such as the genera Argulus, Lernaeac, and Ergasilus, are very serious pests in fish culture, sometimes in nature, and have become increasingly important in recent years (Hoffman 1967).

Salmincola belongs to the order Lernaeopodidea, which has the following key characteristics: cephalothorax short, stout, inclined at angle to body axis; separated from trunk by groove, no distinct dorsal carapace. Trunk short and stout, often flattened dorsoventrally, with no signs of segmentation. No abdomen, caudal rami, or posterior processes. Small transparent genital process present in young females and often in adult organisms. Egg strings usually long and slender (Hoffman 1967).

They are parasitic on freshwater fishes. The typical life cycle includes the following steps:
copepod hatches into small, free-swimming larva which may exist two days; larva possess mouth parts which bear a peculiar filament for attachment to fish; larva forces filament into tissue of fish and attaches second maxillae to filament which becomes the bulla, thus attaching itself permanently to fish. The entire animal undergoes degeneration, becoming a grublike parasite. The male is usually much smaller than female. Copulation occurs two and one-half to three weeks after attachment; male releases hold on gill and attaches to female. After fertilization, male dies. Each female gives rise to two batches of embryonated eggs, after which she dies. Entire life cycle takes about two and one-half months (Fasten 1912, Savage 1935, and Hoffman 1967).

Ichthyophonous, Saprolegnia

During the 1985 survey, two Salmo clarki had fungal infections near the dorsal fin with extensive mycelial masses penetrating the soft tissue. This appeared to be a species of Ichthyophonous (Fig. 7), based on current morphological characteristics.

Fungi are plantlike structures lacking chlorophyll. The assimilative phase consists of a true plasmodium or a mycelium, or rarely of separate uninuclear, independent cells not amoeboïd and at no time uniting as a plasmodiumlike structure (Hoffman 1967).

Ichthyophonous, according to some sources, belongs to the Phycomycetes. Others have avoided trying to place this parasite because it is not a typical member of any class of fungi, thus referring to it as a member of the

Fig. 7. Spores (s) of the fungus Ichthyophonous found in Salmo clarki (400X).
Fungi Imperfecti.

Ichthyophonus hofieri and Ichthyosporidium sp. have been reported from North American rainbow trout (Erickson 1965, Gustafson and Rucker 1956, Ross and Parisot 1958). Ichthyophonus in rainbow trout in North America was first reported by Rucker and Gustafson (1953) from three localities in western Washington. Ross and Parisot (1958) found Ichthyophonus in hatcheries adjacent to the Snake River in south central Idaho.

The organism is commonly found in the kidney, spleen, liver, heart, stomach, intestine, visceral serosa, peritoneal exudate, gills, and brain. In the latest severe epizootic of rainbow trout, the spores were very numerous in the brain as well as in the musculature. Central nervous system involvement apparently resulted in partial denervation of the skeletal musculature, which caused spinal curvature. Cases have been reported on the body surface. Most of the older spores are encapsulated in small host cysts or granulomas.

The other possible taxonomic name for the fungi would be Saprolegnia. This is characterized by: presence of mycelium, usually continuous throughout in active assimilative phase (nonseptate). Species of the genus Saprolegnia are usually implicated in fungal diseases of fish and fish eggs. These fungi of fish are often considered primary or secondary invaders following tissue trauma, but once they start growing on a fish, the lesions usually continue to enlarge and may cause death to the host.

**Ligula**

Ligula is a common plerocercid found in the body cavity of many species of cyprinid and catostomid fish. For the last survey conducted on the parasites of the ichthyofauna of Yellowstone Lake, two of eight longnose suckers contained Ligula plerocercoids. One plerocercid measured 420 mm long by 13.5 mm wide, a length greater than that of the host. The host exhibited organ compression and atrophy, especially gonadal tissue, due to the cestode. In other cases the diseased fish show retarded growth and swollen abdomens.

Ligulosis is caused by the plerocercid of the cestode Ligula, which lives in the intestine of aquatic birds, and its larvae in the visceral cavity of fish. Ligula has no proglot-
tids, and its body shows a median furrow and a fine secondary segmentation, both dorsally and ventrally. The adult lives in the intestine of aquatic birds. The coracidium escapes from the eggs deposited in the water with the excretion of the host bird. This stage is eaten by a copepod (first intermediate host) and becomes a procercoid in the abdominal cavity after having penetrated the intestinal wall. When an infected crustacean is eaten by a fish, the procercoid continues its growth in the abdominal cavity to become the plerocercoid stage, which is present in the longnose suckers.

Histopathologically it is possible to demonstrate compression atrophy, local necrosis, and hemosiderin deposits in the periphery of the liver due to Ligula (Pitt and Grundman 1957).

The results of this study are compared with the 1971 survey (Heckmann 1971) and with the known parasites for cutthroat trout for North America (Table 5). Much data exist pertaining to parasites of Salmo clarki (Hoffman 1967, Heckmann 1971), but with this brief survey four additional parasites are added to the list.

**Table 5 continued.**

<table>
<thead>
<tr>
<th><em>Bulliodacutis scotti</em></th>
<th>Capillaria catarata</th>
<th>Capillaria sp.</th>
<th>Contracaccum sp.</th>
<th>Cucullanus truttae</th>
<th>Cystidicola stagnatana</th>
<th>Cystidicolaides spp.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eustrongylides</strong> sp.</td>
<td>Hepaticola bakeri</td>
<td>Metabronema salvelini</td>
<td>Philometra sp.</td>
<td>Philonema onechrynychai</td>
<td>Rhadchohoma cascadilla</td>
<td>Radhchohoma sp.</td>
</tr>
</tbody>
</table>

Mollusca: (Bivalves)

**Glochidia**

**Heckmann, B. A. 1971.** Parasites of cutthroat trout from Yellowstone-Lake, Wyoming. Prog. Fish Cult. 33: 103-106; and


**LITERATURE CITED**


CHING, H. L. 1985. Occurrence of the eyeblast *Diplodotoma* (Diplodotomidae) of *Bacis* sp. in salmonid fishes of northern British Columbia. Canadian J. Zool.


Spall, R. D., and R. C. Summerfelt. 1969a. Life cycle of the white grub, Posthodiplostomum minimum (MacCallum 1921; Trematoda, Diplohistomatidae), and observations on host-parasite relationships of the metacercariae in fish. Pages 218–230 in S. F. Snieszko, ed., A symposium on diseases of fishes and shellfishes. Special Publ. No. 5 AFS.
