Resurgence of human bothriocephalosis (*Diphyllobothrium latum*) in the subalpine lake region

Raffaele PEDUZZI1) and Renata BOUCHER-RODONI2)

1)Istituto Batteriosierologico Cantonale, Via G. Buffi 6, 6904 Lugano, Switzerland
2)Biologie des Invertébrés marins (BIMM, MNHN), UPESA 8044 CNRS, 55 rue Buffon, 75005 Paris, France
*e-mail corresponding author: raffaele-peduzzi@ti.ch

ABSTRACT

Human bothriocephalosis is once again being found in various catchment basins in the subalpine region, including Lago Maggiore and Lac Léman, which however are not isolated cases. Domestic animals are thought to be responsible for the survival of the parasite during the period when no human cases were reported. The new phenomenon of eating raw or poorly cooked fish is responsible for the resurgence of human bothriocephalosis, which affects various lake districts in Europe. This habit of eating raw fish might lead to the resurgence of a much more dangerous human parasitosis, transmitted in a similar way: infestation by *Anisakis*.

Key words: Bothriocephalosis, *Diphyllobothrium*, Subalpine region

1. INTRODUCTION

Water is a vehicle for many infectious and parasitic agents. Changes in social, cultural and agricultural habits have been accompanied by changes in the health risks associated with water. Human infection by *Diphyllobothrium latum* (Cestoda: Pseudophyllidae), the broad tapeworm, is caused by the ingestion of raw or poorly cooked fish containing plerocercoid larvae. The infestation can occur only if the larvae are still alive after their ingestion. Maturation lasts for 5 to 6 weeks before egg production; the adult worm can be over 10 meters long and contains 2000-3000 proglottids. Diagnosis is usually based on the identification of characteristic eggs or proglottids in human faeces. The life cycle of the parasite includes two intermediate hosts (copepod and fish, Fig. 1). The occurrence of this parasite was originally restricted to the «old world», i.e. in lakes of various European countries such as Sweden, Finland, Russia, Poland, Rumania, Austria, Scotland, Ireland (O’Fel 1992; Dorucu et al. 1995; Byrne et al. 2000). Bothriocephalosis was apparently already present during pile-dwelling times: eggs have been found in human coprolites from Neolithic sites, in Jura (Bouchet 1997). Its introduction into the United States is recent. Cases have also been reported lately from Argentina and Chile (Semenas & Ubeda 1997) and from Asiatic countries like Japan and Korea, where the consumption of raw fish is common (Chung et al. 1997).

It used to be thought that this parasitosis had disappeared from many European and American regions. However, this paper reports that *Diphyllobothrium* is still present in fish samples from Lago Maggiore and Lago d’Orta, and that human infestation has been increasing in recent years in the subalpine region.

2. MATERIAL AND METHODS

2.1. Human faeces analyses

Over 35,000 samples of human faeces were analysed in the last ten years, and tested for helminth infestation. To detect the presence of *Diphyllobothrium*, the samples were homogenised by a stomaker and by a diphasic technique derived from the Telemans-Rivas method (Bourée 1989). After centrifugation, *Diphyllobothrium* eggs were examined under a light microscope.
Fig. 2. Microscope view of *Diphyllobothrium latum* eggs, showing the high density of their release, which can reach one million eggs a day. Size of a single egg: 50 × 70 µm.

Fig. 3. Fish muscle (*Perca fluviatilis*) infestation by a large number of plerocercoid larvae of *Diphyllobothrium latum*. Scale 8×.

Fig. 4. Scanning electron microscope view of a plerocercoid larva of *Diphyllobothrium latum*: detail of buccal apparatus. Scale 45×.
2.2. Fish examination

Muscle samples of *Perca fluviatilis* were collected in various lakes from the subalpine region along the Swiss-Italian border (Tab. 1), and tested for the presence of parasite larvae by anatomic and microscopic observation.

**Tab. 1.** Presence of *Diphyllobothrium latum* larvae in the muscles of perch (*Perca fluviatilis*) from five Italian and Swiss-Italian subalpine lakes. I = Italy; CH = Switzerland.

<table>
<thead>
<tr>
<th>Lake</th>
<th>N° fish</th>
<th>N° <em>D. latum</em> larvae</th>
<th>% infec.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lugano (I-CH)</td>
<td>107</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Varese (I)</td>
<td>35</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mergozzo (I)</td>
<td>50</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Maggiore (I-CH)</td>
<td>309</td>
<td>24</td>
<td>7.8</td>
</tr>
<tr>
<td>Orta (I)</td>
<td>15</td>
<td>5</td>
<td>33.3</td>
</tr>
</tbody>
</table>

2.3. Electron microscope analyses

The samples were dehydrated in a series of ethanol baths of increasing concentration (20 to 100%, 10 min. per bath) followed by a last bath in pure acetone, before being transferred to the CO₂ critical point dryer CPD-030 (Balzers). Gold shadowing was performed in a sputter coater SDC-050 (Balzers), before observation with a scanning electron microscope (ISI SS40).

**Tab. 2.** Species and frequency of helminth isolated from human faeces from 1982 to 1999, out of 37,800 analyses.

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Trichuris trichiura</em></td>
<td>138</td>
</tr>
<tr>
<td><em>Taenia</em> sp.</td>
<td>127</td>
</tr>
<tr>
<td><em>Enterobius vermicularis</em></td>
<td>66</td>
</tr>
<tr>
<td><em>Ascaris lumbricoides</em></td>
<td>44</td>
</tr>
<tr>
<td><em>Diphyllobothrium latum</em></td>
<td>31</td>
</tr>
<tr>
<td><em>Ancylostoma</em> sp.</td>
<td>31</td>
</tr>
<tr>
<td><em>Hymenolepis</em> sp.</td>
<td>12</td>
</tr>
<tr>
<td><em>Strongyloides stercoralis</em></td>
<td>9</td>
</tr>
<tr>
<td><em>Dicrocoelium</em> sp.</td>
<td>8</td>
</tr>
<tr>
<td><em>Schistosoma haematobium</em> (urine)</td>
<td>5</td>
</tr>
<tr>
<td><em>Trichostrongylus</em> sp.</td>
<td>1</td>
</tr>
<tr>
<td><em>Clonorchis sinensis</em></td>
<td>1</td>
</tr>
<tr>
<td><strong>Total number of cases</strong></td>
<td><strong>476</strong></td>
</tr>
</tbody>
</table>

3. RESULTS AND DISCUSSION

In the Swiss-Italian subalpine region, considered in this study, *Diphyllobothrium latum* infestation in man had been presumed extinct since 1970. However, a first new case was identified from human faeces in 1983, and since then 31 other cases have been reported in the local population (anamnesis excludes infection from other sources), indicating that the parasitosis is now in progress (Peduzzi 1990; Fig. 2). At present, in the geographical area considered, infestation by *Diphyllobothrium* is the most frequent in man after *Taenia, Trichuris* and *Ascaris* (Peduzzi & De Rossa 1999; Tab. 2). The percentage of *Diphyllobothrium* eggs varied from 0.3 to 0.4% of all the samples analysed in this study, a much higher value than the 0.01% frequency reported for this parasite by the CDC, Atlanta, on the basis of epidemiological data relating to USA (Stürchler 1986).

**Tab. 3.** Presence of *Diphyllobothrium latum* larvae in the muscles of perch (*Perca fluviatilis*) from Lago Maggiore. I = Italy ; CH = Switzerland.

<table>
<thead>
<tr>
<th>Fishing zones</th>
<th>N° samples</th>
<th>N° <em>D.l.</em> larvae</th>
<th>% infec.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riva Piana-Muralto (CH)</td>
<td>29</td>
<td>4</td>
<td>13.8</td>
</tr>
<tr>
<td>Bolle Magadino (CH)</td>
<td>15</td>
<td>1</td>
<td>6.7</td>
</tr>
<tr>
<td>San Nazzaro (CH)</td>
<td>11</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Ranzo (CH)</td>
<td>12</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Foce Ticino Verzasca (CH)</td>
<td>22</td>
<td>3</td>
<td>13.6</td>
</tr>
<tr>
<td>Vira Cambarogno (CH)</td>
<td>28</td>
<td>3</td>
<td>10.7</td>
</tr>
<tr>
<td>Laveno (I)</td>
<td>80</td>
<td>5</td>
<td>6.2</td>
</tr>
<tr>
<td>Angera (I)</td>
<td>50</td>
<td>1</td>
<td>2.0</td>
</tr>
<tr>
<td>Arona (I)</td>
<td>15</td>
<td>2</td>
<td>13.3</td>
</tr>
<tr>
<td>Stresa (I)</td>
<td>15</td>
<td>3</td>
<td>20.0</td>
</tr>
<tr>
<td>Baveno (I)</td>
<td>16</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Verbana (I)</td>
<td>16</td>
<td>2</td>
<td>12.5</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>309</strong></td>
<td><strong>24</strong></td>
<td><strong>7.8</strong></td>
</tr>
</tbody>
</table>

As far as fish infestation is concerned, pleurocercoid larvae are found in fish muscle (Figs 3 and 4). A high infestation rate is recorded in perch (*Perca fluviatilis*) from many fishing areas of Lago Maggiore (Bonini et al. 1998; Tab. 3); the infestation is also in progress in other subalpine lakes, such as the Franco-Swiss lac Léman (Peduzzi et al. 1994). However, the resurgence of human bothriocephalosis is not restricted to these two major lakes, but involves most of the catchment basins in the entire subalpine region (Tab. 4). In addition, Go- lay & Mariaux (1995) reported 73 cases of bothriocephalosis from various areas in Switzerland, including the Léman region (Geneva, Vaud), but also Neuchâtel, Fribourg and Bern.

**Tab. 4.** Cases of human bothriocephalosis reported from various laboratories (1990-1995). I=Italy; CH=Switzerland; F=France.

<table>
<thead>
<tr>
<th>Lake</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>L. Léman (F-CH)</td>
<td>24</td>
</tr>
<tr>
<td>L. Maggiore (I-CH)</td>
<td>28</td>
</tr>
<tr>
<td>L. Como (I)</td>
<td>1</td>
</tr>
<tr>
<td>L. Iseo (I)</td>
<td>8</td>
</tr>
<tr>
<td>L. Garda (I)</td>
<td>12</td>
</tr>
</tbody>
</table>

These results show that the parasite cycle was still active even when the disease did not appear in humans. Man is not the only ultimate host, so that the cycle may have been maintained through domestic animals (mainly cats and dogs). Human beings used to be protected by the habit of cooking fish at high temperatures, since the
most effective means of killing the parasite is by heating or freezing (Tab. 5).

**Tab. 5.** Survival of plerocercoid larvae to freezing and heating.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Survival time</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10°C</td>
<td>1-7 days</td>
</tr>
<tr>
<td>+4°C</td>
<td>72 hours</td>
</tr>
<tr>
<td>+50°C</td>
<td>10 min.</td>
</tr>
</tbody>
</table>

Changes in eating habits, i.e. the consumption of raw or poorly cooked fish, popularised by specialised restaurants, have caused infestation in humans to reappear in areas where it was considered extinct. This alerts us to the risk of another infection, in which the process of contamination is similar but which is much more dangerous: infestation by *Anisakis*. In any case, eating raw or poorly cooked fish from lakes or sea can increase the risk of food-transmitted dangerous parasitosis in man.

REFERENCES


Received: January 2000
Accepted: March 2001