Contribution to the problem on feeding
Tendipes plumosus in the Rybinsk water reservoir

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CONTRIBUTION TO THE PROBLEM ON FEEDING TENDIPES PLUMOSUS IN THE RYBINSK WATER RESERVOIR

BY

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A study of nutrition of Tendipes plumosus in the Rybinsk water reservoir was undertaken in order to ascertain the causes of its very irregular distribution therein. Most of the larvae are confined to the banks of the reservoir or to the estuary zones of rivers; whereas in the open portion of the reservoir T. plumosus is found in insignificant numbers, and there are even some zones in which the larvae are entirely absent (Mordukhai-Boltovskoy, 1955; Poddubnaya, 1958). As was found by A. I. Shilova (1958), the distribution of the midge in the reservoir is in the main determined by nutritional conditions for its larvae. Therefore, a study of T. plumosus nutrition acquires a particularly important significance.

We began a study of T. plumosus nutrition by analysing the intestinal contents of various larvae obtained from different zones of the reservoir.
With this purpose in view the larvae were examined during May benthic survey in 1958; and regular collections of larvae were made during the period between November, 1957 and November, 1958 from the old bed of the Volga river in a section Borok - Koprino (Station 1 of the standard benthic survey). At each station 3 - 5 larvae of the fourth instar, sized 18 - 20 mm., were examined. The larvae were autopsied while still alive, immediately after samples were taken. The entire contents of the intestinal tract were smeared over an area of 4 - 8 square centimeters of the object glass, to which was added .02 - .04 per cent of agarized ultra-filtered water. Subsequent staining with 5 per cent carbol-erythrosine enabled us to count the number of bacteria in the intestinal tract.

Examination of such preparations showed that the intestinal contents consisted of more or less uniform particles which may be differentiated into the following groups: organic particles, mineral particles, algae and bacteria. The percentage of each of these components was determined by the eye in 30 fields of vision, each with the most characteristic disposition of particles. A similar method of examination is accepted in practical studies of peat (Korotkina, 1939) and in studying nutrition of the fishes and invertebrates (Sadler, 1935; Stoykina, 1957; Smirnov, 1959). The counting of bacteria was based on 20 fields of vision.

1. A short period of survey (10 days) enabled us to obtain comparable data.

2. In elaborating the method of counting bacteria during subsequent examination of the preparation, the author made use of valuable suggestions of S.I. Kuznetzov to whom he expresses his deep gratitude.

3. An experiment involving the examination of the same preparation by different persons convinced us that the error in counting does not exceed 5 per cent.
**COMPOSITION OF INTESTINAL CONTENTS OF TENDIPES PLUMOSUS FROM DIFFERENT ZONES OF THE RESERVOIR**

<table>
<thead>
<tr>
<th>Type of substrate/the Bottom of the Reservoir</th>
<th>Bacteria in Millions Per Larva</th>
<th>Organic Particles</th>
<th>Mineral Particles</th>
<th>Algae</th>
<th>Bacteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peaty bottom mud/silt:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Station 32</td>
<td>7.5</td>
<td>61</td>
<td>23</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>Station 75</td>
<td>6.3</td>
<td>50</td>
<td>21</td>
<td>28</td>
<td>1</td>
</tr>
<tr>
<td>Silted/muddy/sand:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) heavily silted St. 28</td>
<td>17.5</td>
<td>56</td>
<td>32</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>b) slight deposit of silt St. 17</td>
<td>5.3</td>
<td>44</td>
<td>20</td>
<td>35</td>
<td>1</td>
</tr>
<tr>
<td>c) silted St. 1</td>
<td>10.6</td>
<td>35</td>
<td>7</td>
<td>49</td>
<td>9</td>
</tr>
<tr>
<td>St. 21</td>
<td>17.5</td>
<td>28</td>
<td>23</td>
<td>47</td>
<td>2</td>
</tr>
<tr>
<td>Sandy bottom:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) with clay St. 47</td>
<td>9.9</td>
<td>23</td>
<td>12</td>
<td>64</td>
<td>1</td>
</tr>
<tr>
<td>b) with bottom ground of transitional type</td>
<td>7.0</td>
<td>20</td>
<td>1</td>
<td>78</td>
<td>1</td>
</tr>
<tr>
<td>Sapropel mud/silt: St. 4'</td>
<td>13.5</td>
<td>32</td>
<td>36</td>
<td>30</td>
<td>2</td>
</tr>
<tr>
<td>Sapropel mud with admixture of peat particles</td>
<td>10.8</td>
<td>43</td>
<td>27</td>
<td>29</td>
<td>1</td>
</tr>
</tbody>
</table>
Fig. 1 Seasonal changes in the composition of intestinal contents of *T. plumosus* at Station 1.

The figures indicate percentages of the individual components of the total intestinal contents: a) Bacteria; b) Algae; c) Mineral Particles; d) Organic Particles.
Figure 1 and the Table provide a pictorial representation and general idea about the intestinal contents of T. plumosus in the Rybinsk water reservoir. Different bacteria were encountered therein. The cocci occupied the leading place. A certain proportion of bacteria (up to 10 per cent) consisted of rod-shaped bodies of varying size. Occasionally microorganisms shaped like convoluted threads were seen, or they assumed the shape of dendroid rods (something like mycobacteria according to the definition of I.N. Dzyuban). Yeasts, too, occurred fairly often. But the bacteria, as will be seen from the Table and Fig. 1, represented only an insignificant portion of the food clump. In summertime their share rarely exceeds 5 per cent. In wintertime their share may be up to 25 per cent. But in general in wintertime only small numbers of larvae feed, if at all (20 to 30 per cent); their intestinal tracts are not fully filled, often containing only a few food clumps (According to a 5 point scale, the degree of filling at that period may be expressed as 0 - 1).

The role played by the algae in T. plumosus nutrition is also comparatively small. During the entire period of our investigation in the course of a year at Station 1, the share of algae never exceeded 50 per cent, being on an average 20 - 30 per cent (Fig. 1). We see a similar picture in other zones of the reservoir (See the Table), where the algae constituted a greater portion of the food clump (78 per cent) at one station only. In all the remaining stations the algae component did not exceed 50 per cent, likewise being an average of 30 per cent. In summertime the role of algae in the nutrition of T. plumosus becomes greater (Fig. 1). Two rises in their percentage content are observed, coinciding, as it were, with the peaks of development of the Melosira sp. in the water. The Melosira sp. was found in the intestinal tracts of all
larvae autopsied by us. Its share represents about 90 per cent of all the algae found by us in the intestinal tracts. The second place is occupied by the Asterionella sp. Thus, the algae so found are mainly the diatoms. During some periods (in September) the blue-green algae were found, mainly the Microcystis sp., occasionally the Aphanizomenon sp. The Scenedesmus sp. was almost always present but only in infinitesimal numbers.

The organic and mineral particles formed a greater portion of the food clump, the former being on an average 40 and the latter 30 per cent of the food mass. The organic particles predominated in winter-time (58 - 87 per cent), and the share of mineral particles was high in collections made in the month of May (43 - 51 per cent), which is probably due to spring floods. But the seasonal changes are in general fairly slight and involve mainly the quantities of algae and bacteria.

The organic particles differ from the mineral particles by their opacity and a darker coloration. It is difficult to determine their origin, but they form the main body of the detritus. Besides those, bacteria and remnants of algae are probably the other components of the detritus.

Thus, it may be said that the detritus predominates as the component of food found in T. plumosus in the Rybinsk reservoir.

In other reservoirs the picture of intestinal contents may be different. In her collections - Borodich (1956) - from small ponds of the
Timiryazev park, the unformed particles accounted for only a fairly small proportion of the food clump of *T. plumosus*, and this author therefore confined herself to determining the algae alone. According to the data of A.S. Konstantinov (1958), in the ponds of the fish breeding plant "Teplovka" in Saratov Province, the intestinal contents of *T. plumosus* found there contained 51 per cent (by weight) of bottom soil and detritus, and 20 per cent of algae, the figures closer to our own. In the intestinal tracts of *T. plumosus* found in these ponds there "regularly occurred - in addition to plant food - food of animal origin, in fairly considerable quantities" (the frequency of occurrence of the fresh water crustaceans was 33 per cent and their weight represented 8 per cent of the total food mass); and not rarely these crustaceans still showed the signs of life, which may be an indication - according to the author's assertion - that "these animals were actually captured by the larvae". A.S. Konstantinov - basing his opinion on this fact - considers that larvae of the genus *Tendipes* should be regarded as omnivorous forms. According to the data of our autopsies, the larvae found in the Rybinsk water reservoir did not feed on food of animal origin. It is possible that Sadler (1935) was right in asserting that remains of animals found by him in the intestinal tracts of *Tendipes tentans* were present in and ingested by the larvae with the food on which they fed, but do not provide evidence of their predacious tendency. Apparently, another assertion of Sadler is also true when he says that "the locality where the larvae feed determines the variation in the composition of their food; but where the algae are present in sufficient quantities, they represent the greater portion of the food".
In different biotopes of the Rybinsk reservoir, the share by percentages of different components differs greatly (See the Table). The percentage of mineral particles in the larvae collected from different types of bottom ground fluctuated in most cases very little - between 20 and 36 per cent - but it was much smaller at some stations (Station 1, 60, 47). The percentage share of the algae fluctuated in the larvae obtained at different stations between 10 and 78 per cent, whereas that of organic particles fluctuated between 20 and 61 per cent. Very likely, this phenomenon is due in a greater degree to the amount of organic particles present in the substrate or in the benthic water layers. The greatest share by percentage of organic particles was found in the intestinal tracts of larvae obtained from peaty silt (50 - 61 per cent), from silty sands (28 - 56 per cent, with an average of 40 per cent); whereas in those larvae obtained from sand free from silt, the percentage was even smaller (20 - 23 per cent). Yet the organic particles originating from different types of substrates do apparently differ from each other; and therefore no accurate judgement can be formed as to their significance by merely noting their percentages in the larvae. The organic particles from the peaty grounds are assimilated badly. Their greater percentage in the intestinal tract, in combination with the mineral particles that cannot be assimilated, furnish evidence that larvae exist under bad nutritional conditions.

The data we obtained on the total number of bacteria in the intestinal tracts should be regarded, for the purpose of evaluation, only as the preliminary ones. The total number of bacteria found in a single intestinal tract fluctuated from 300,000 in wintertime when the
Fig. 2 Number of bacteria in the intestinal tracts of *T. plumosus* (Station 1)
larvae hardly feed at all to 32 millions (in some individuals) in summertime, the period of intensive feeding. An increase in the number of bacteria toward summertime is clearly illustrated (Fig. 2). This fact is apparently associated with a general increase in the number of bacteria in the substrate on the one hand, and with the greater intake of food by the larvae on the other. Of the latter (the greater intensity of feeding) the evidence is provided by the extent to which the intestinal tract is filled (with ingesta) which at that period reached its maximum (5 points on a five points scale). Generally, in a period between winter and summer the extent to which the intestinal tract becomes filled increases gradually. In wintertime the larvae hardly feed at all, and the extent to which their intestinal tract is filled with ingesta - as already noted above - does not exceed (on the same scale) 0 - 1 points; in the spring when the larvae begin to feed, its extent of filling increases to 3 and 3 - 4 points; and in summer months it reaches 5 points.

In different biotopes of the reservoir the number of bacteria found in intestinal tracts varied from 5 to 18 millions (See the Table). Their greatest number was found in the larvae obtained from areas with silty sand bottom (Stations 28, 21 - 17.5 million); the less silt is present in the sand the smaller the number of bacteria. In a bottom with sand hardly having any silt deposit very few bacteria are present (5.3 million). Likewise, the number of bacteria found in the larvae collected from areas with peaty silt (Stations 32 and 75 - from 6.3 to 7.5 million) is fairly small; that goes for the areas containing other types of silt with an admixture of peat particles.
Thus, at Station 4 the number of bacteria on the sapropel silt was fairly large (13.5 million); whereas, at Station 2 a - where peat particles are mixed with the latter type of silt, lesser numbers of bacteria are found, and it was much smaller at Station 60 (7 million).

Although the absolute numbers of bacteria present in the intestinal tracts are enormous, their share by percentage in the intestinal contents is small. Judging by the percentages of various components, the basic role in the nutrition of _T. plumosus_ larvae in the Rybinsk water reservoir belongs to the detritus. Yet, in the relevant literature there are convincing data that provide evidence of the important role played by bacteria in the nutrition of the _Tendipedidae_ larvae (Gorbunov, 1946; Rodina, 1949). In order to ascertain which of the components of the food consumed are of greatest importance for normal nutrition and development of the larvae, the metabolism (of components) should be experimentally studied.
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