TISCIA /SZEGED/ 6, 1970-71.

# Effect of the waste-water of sogar-works on natural history of the river Zagyva

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/Received December 3rd 1969/

Abstract

The present paper is analysing the chemical composition and natural history of the river Zagyva, as well as their change as a result of various waste-waters. It is establishing that the effect of the standing pollution depends upon the water output, while the influence of periodical pollutions /waste-water waves/ depends first of all upon the storage time of waste-water.

About the natural history of the river Zagyva there have been issued so far but a few scientific publications, only the monographs of S z e m e s /1940, 1947, 1948/ and U h e r k o v i c h /1966 a, 1968/ being known. Water-chemical data were published by S c h i k /1933/ and P a p p /1961/. The chemical and recently the biological state of its water is followed with attention systematically by organs of water conservancy, owing to the practical importance of the question / G u l y á s 1964, H a m a r 1967/. The utilization of water of the 180 km long Zagyva is manifold; irrigation, industrial water drawing, well-drain and inland water drainage. Its water output is changing /310-0,2 $m^3$/sec./, depending mostly on the water output of streams flowing into it. The industrial waste-waters are the most important ones of the permanent sources of pollution. The galvanizing, oleiferous, tar-waters of the industrial works in Salgotarján, Hatvan and Jászbereny are spelling a grave loading on the Zagyva. /Fig.1/, mainly because of being toxic and hardly dissociable. The seasonal industrial pollutions are caused by the waste-water of the sugar-works in Selyp and Hatvan. The effect of the wáste-waters pouring into it continually depends, in fact, on the water output of the Zagyva, and the waste-waters pouring into it seasonally are superposed upon that basic loading.

## Materials and methods

Our laboratory performs water-quality investigations in five sample areas a month, investigating the whole polluted section in the time of waste-water waves. The analysis was carried out by means of samples obtained by drawing and netting. The chemical investigations were carried out whith COMECON-methods, the basic biological qualification with P a n t l e B u c k's /1955/ method / $S = \frac{\Sigma s.h}{\Sigma h}$ /.

The figure of frequency /1-3-5/ was established by estimation. It is demonstrated by practice that P a n t l e - B u c k's formula can generally be used for detecting pollutions in case of river Zagyva. For determining *Protozoa*, mainly we have aplied vital staining. The determination of organisms was carried out from the fundamental works of H o r t o b á g y i, H u b e r - P e s t a l o z z i, K a h l, P a s c h e r, S l a d e c e k and U h e r k o v i c h.

## Results

The water of the river Zagyva is of medium hardness, the dominance of ions $Ca^{++}$, $Mg^{++}$, $SO_4^{--}$, $HCO_3^-$ is characteristic of it, the content of the total dissolved matter in it is changing /400-1300 mg/l/. Its chemical composition is influenced by its state of pollution /Table 1/. It is characteristic of the state of water quality in the Zagyva, besides the waste-water waves, that it is made poly-α -mezosaprobical by the stream Tarján flowing into it at its upper reaches and carrying the industrial and house waste-waters of Salgótarján. But in the most polluted state the water was antisaprobical. The β-mezosaprobical water of the Zagyva reaches above Hatvan is, as a result of the waste-waters of the town, again polluted /polysaprobical/. Until Jászberény it becomes considerably clearer /β-mezosaprobical/, the waste-waters of the town exert their effect but on a short section. On the lower reaches between Jászberény and Szolnok there is no major waste-water influence. We found the biologically clearest picture at inundations. The biological state of the lower reaches is influenced strongly by the damming effect of the river Tisza. In case of law water the pollution is stronger /Table III, 8/.

From the microorganisms the algae are dominating, mainly the diatoms whose composition changes depending upon the character of reaches and the degree of pollution /Table II, III/. *Chlorophyceae* appear in higher number in the vegetation period, *Euglenophyta* at a higher degree of pollution. According to our observations, *Cyanophyta* increase at law water, in warm weather, mainly those indicating a strong pollution /Table III, 8/.

The state of water quality of the river Zagyva is the most homogeneous in the season of waste-water waves. The storage tank of the sugar-works in Selyp had a capacity of 6500 $m^3$ in 1965, 168.000 $m^3$ in 1967, the former one with a storing time of 8-10 days, the latter with that of 20-21 days. The waste-waters of a short storing period like that are at the beginning of the processes of anaerobic dissolution. They contain much organic matter and floating sediment, their BOD. is 90-400 mg/l. Apart from bacteria -among them streptococci- only flagellatae can be found in them. /Table II, 2/ The amount of the waste-water emitted is about 1 $m^3$/sec., corresponding to the water output of the Zagyva. Later on, that water becomes diluted but its quality is hardly changing. At that time, the water of the Zagyva becomes stinking, of black colour, strongly reductive /Table I. 3/.

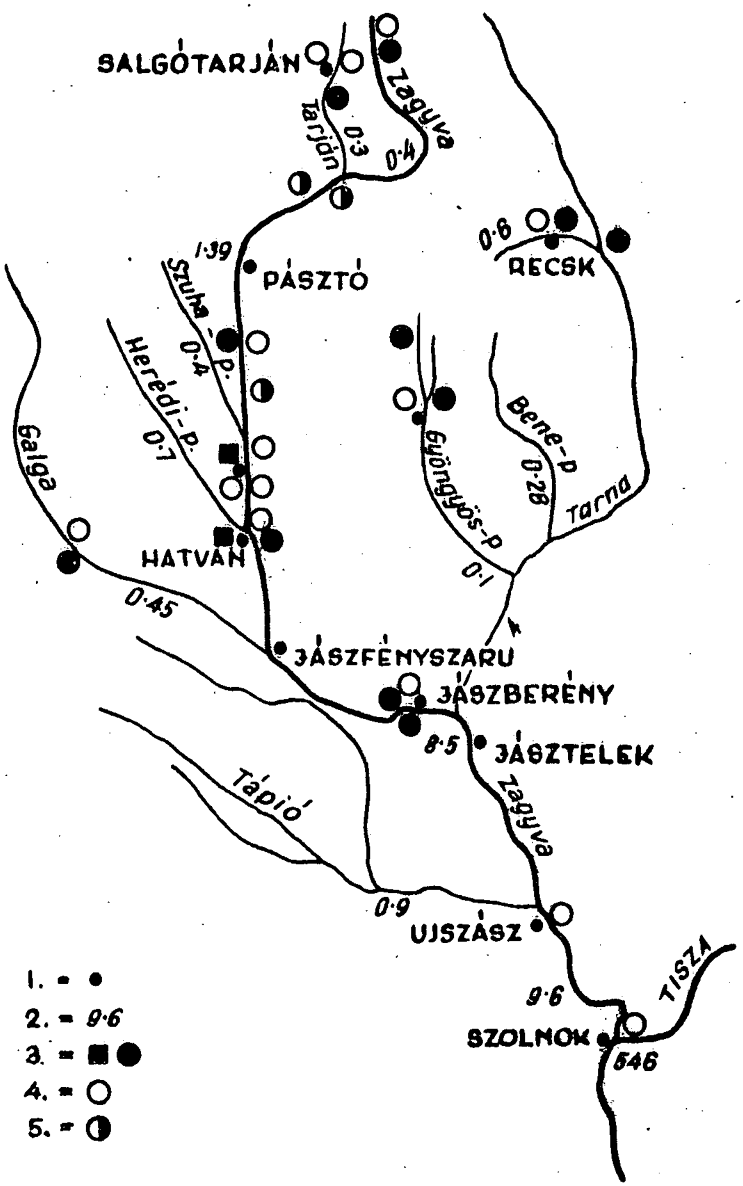


Fig. 1. Waste-water sources of the river Zagyva

Legend; 1. Settlement , 2. Mean water output , 3. Industrial waste-water , 4. House waste-water , 5. Industrial and house waste-water.

The biological qualification has demonstrated only little change in the longitudinal section of the river Zagyva. *Nitzschia palea* that appears in the lower reaches is demostrating that some change took place in the quality of water /Table II, 3-7/. At the mouth of river, the effect of the waste-water wave can be observed well /Fig. 2/. The pollution of that degree turns the Zagyva into a sewer, extreninating almost fully its natural fauna and flora and making its influence feel even after the waste-water wave had passed. According to the data of fishery, in campaign of sugar-works each, there perish about 2-300 q /cca. 4-600 cwt/ fish, for the most part carp, bream, and catfish.

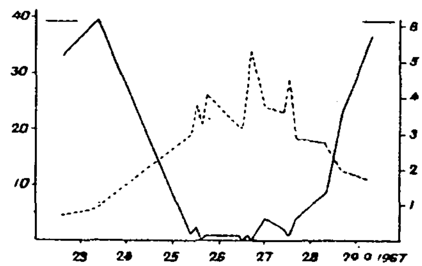


Fig. 2. Change in the oxygen management at mouth of the river Zagyva, as a result of waste-water from the sugar-works in Selyp.

Legend; ________ dissolved $O_2$ mg/l , _ _ . _ _ $O_2$ decrease mg/l

Things are not the same in case of the sugar-works in Hatvan. This factory has a storage tank of 550.000 $m^3$. It pours its waste-water into the river Zagyva after finishing the period of its campaign, at high water. The waste-water itself, too, is in a more advanced state of self-purification than that of the sugar-works in Selyp. In addition to *Bacteria*, there are in its water *Protozoa* and *Algae*, as well. Owing to the stronger dilution, this waste-water can become clear in the Zagyva, being indicated there by the discolouration of the water, too. It rather increases the nutriment content of the river and passes without any major damage /Table III, 4-6/.

A specialist, after surveying the list of taxons, can ascertain how variegated the microflora and fauna of the river Zagyva /between Selyp and Szolnok/ is. It will be the task of further investigations to reveal the causes and regularities of the changes in the natural history.

The microorganisms of the river Zagyva /Selyp - Szolnok/;

*Schizomycetes*

1. *Beggiatoa alba* Trev.
2. *Coccus*
3.

3. *Filamentous bac.*, in the time of the waste-water waves of the sugar-works and canning factory there was in the water a large amount of characteristic, long / 100-200 μ/ bacteria.
4. *Sarcina palludosa* S c h r o e t e r
5. *Spaerotilus natans* K ü t z ., being observed in the neighbourhood of sewage pipes of the sugar-works and at low water near to the mouth, as well /Table II, 8/, with thalluses both in the plankton and benthos equally.
6. *Spirillum undulans* E h r .
7. *Spirillum* spp.
8. *Streptococcus margaritaceus* S c h r o e t e r
9. *Thiotrix nivea* / R a b. / W i n o g.
10. *Thiovolum* sp.
11. *Zoogloea ramigera* I t z i g.

*C y a n o p h y t a*

12. *Achronema articulatum* S k u j a, its trichom being straight or somewhat curved, the cells strongly laced. The granules of protoplasm are denser in the longitudinal axis of the cell, in the middle of it. Cell sizes; 8,3 - 10 x 2,5 μ/ Fig. 3, 13/.
13. *Coelosphanium kutzingianum* N ä g.
14. *Coelosphaerium pusillum* v a n G o o r
15. *Merismopedia elegans* A. B r .
16. *Merismopedia minima* G. B e c k
17. *Merismopedia tenuissima* L e m m
18. *Miscrocystis aeruginosa* K ü t z
19. *Oscillatoria amphibia* A g .
20. *Oscillatoria chlaybea* M r t .
21. *Oscillatoria chlorina* K ü t z.
22. *Oscillatoria granulata* G a r d .
23. *Oscillatoria lauterbornii* A g., the trichom of green colour is straight or mildly curved, the 2,5 μ wide and 3,3 - 5 μ long cells at the cross-wall are not laced. In the middle of cell 1-3 gas vacuoles of irregular shape can be observed /Fig. 3, 8/. It can be found in a highly polluted water, first of all associated with *Beggiatoa alba* and *Oscillatoria chlorina*.
24. *Oscillatoria limosa* A g.

25. *Oscillatoria pseudogeminata* G. Schmid
26. *Oscillatoria putrida* Schmidle
27. *Oscillatoria tenuis* Ag.

Chrysophyta - Chrysophyceae

28. *Dinobryon divergens* Imhof
29. *Synura uvella* Ehr

Chrysophyta - Bacillariophyceae

30. *Achnantes lanceolata* /Breb./ Grun.
31. *Achnantes microcephala* Kütz.
32. *Achnantes minutissima* Kütz.
33. *Amphora ovalis* Kütz.
34. *Caloneis amphisbaena* /Bory/ Cl.
35. *Cocconeis placentula* Ehr.
36. *Cocconeis placentula* var *euglypta* /Ehr./ Cl.
37. *Cymatopleura elliptica* /Bréb./ W. Smith
38. *Cymatopleura solea* /Bréb./ W. Smith
39. *Cymatopleura solea* var. *regula* /Ehr,/ Grun
40. *Cymbella ventricosa* Kütz.
41. *Diatoma elongatum* /Lyngb./ Ag.
42. *Diatoma vulgare* Bory
43. *Fragillaria capucina* Desm.
44. *Fragillaria crotonensis* Kitt.
45. *Gomphonema constrictum* Kütz.
46. *Gomphonema olivaceum* /Lyngb./ Kütz.
47. *Gomphonema parvulum* /Kütz./ Grun.
48. *Gyrosigma attenuatum* /Kütz./ Rabh.
49. *Hantzschia amphioxys* /Ehr./ Grun.
50. *Melosira granulata* /Ehr./ Ralfs.
51. *Melosira granulata* var. *angustissima* /O. Müll/ Hust.
52. *Melosiara varians* Ag.
53. *Navicula cryptocephala* Kütz.
54. *Navicula hungarica* Grun.

55. *Navicula pygmea* K ü t z .

56. *Navicula rhynhocephala* K ü t z .

57. *Navicula viridula* K ü t z .

58. *Nitzschia acicularis* W. S m i t h .

59. *Nitzschia capitellata* H u s t .

60. *Nitzschia closterium* / E h r./ W. S m.

61. *Nitzschia gracilis* H a n t z s c h .

62. *Nitzschia linealis* W. S m i t h .

63. *Nitzschia palea* / K ü t z / W. S m i t h .

64. *Nitzschia sigmoidea* / E h r./ W. S m i t h .

65. *Nitzschia tryblioella* H a n t z s c h .

66. *Rhoicosphenia curvata* / K ü t z ./ G r u n .

67. *Stephanodiscus hantzschii* G r u n .

68. *Suriella robusta* var. *splendida* / E h r./ V. H.

69. *Suriella ovata* K ü t z./

70. *Suriella ovalis* B r é b .

71. *Synedra acus* K ü t z .

72. *Synedra affinis* K ü t z .

73. *Synedra ulna* / N i t z s./ E h r .

*C h r y s o p h y t a - X a n t o p h y c e a e*

74. *Tribonema vulgare* P a s c h ., caused water-colouration in the protruded branches of the river; in its bed I did not find it /July 11th 1969/.

*E u g l e n o p h y t a*

75. *Anisonema acinus* D u j .

76. *Astasia klebsii* L e m m .

77. *Euglena acus* E h r .

78. *Euglena intermedia* S c h m i t z .

79. *Euglena polymorpha* D a n g .

80. *Euglena proxima* D a n g .

81. *Euglena oxyuris* f. *minor* D e f l .

82. *Euglena tripteris* / D u j./ K l e b s .

83. *Euglena viridis* E h r .

84. *Lepocynclis ovum* / E h r./ M i n k .

85. *Phacus curvicauda* S v i r .

86. *Phacus longicauda* / E h r./ D u j .

87. *Phacus pleuronectes* /O. F. M./ D u j .

88. *Phacus wetsteinii* D r e z .

89. *Peranema trichophorum* C h e n .

90. *Menoidium falcatum* Z a c h a r .

91. *Trachaelomonas acuminata* / S c h m a r d a / S t e i n

92. *Trachaelomonas fluviatilis* L e m m .

93. *Trachaelomonas granulosa* P l a y f .

94. *Trachaelomonas hispida* /P e r t y/ S t e i n

95. *Trachaelomonas intermedia* D a n g .

96. *Trachaelomonas scabra* P l a y f .

97. *Trachaelomonas volvocina* E h r .

98. *Trachaelomonas volvocina* var. *granulosa* P l a y f .

*C h l o r o p h y t a - C h l o r o p h y c e a e*

99. *Actinastrum hantzschii* L a g e r h .

100. *Ankistrodesmus falcatus* var. *acicularis* /A.B r./ W e s t

101. *Ankistrodesmus falcatus* var. *mirabile* W. et. W.

102. *Ankistrodesmus falcatus* var. *spirilliformis* G. S. W e s t

103. *Ankistrodesmus longissimus* W i l l e

104. *Ankistrodesmus setigerus* /S c h o e r e d/ G.S. W e s t

105. *Chlamydomonas ehrenbergii* G o r .

106. *Chlamydomonas pertusa* C h o d .

107. *Chlamydomonas simplex* P a s c h e r .

108. *Chlorella vulgaris* B e i j .

109. *Chodatella balatonica* S c h e r f f e l

110. *Chodatella ciliata* L e m m., on the poles of the ellipsoidal cell thin, curved shikes are sitting. Size of cell; 11,6 x 8.3 μ the length of spikes being 9,2 - 10,8 μ /Fig. 3,2/.

111. *Chodatella longiseta* L e m m., the length of cell is lo,8 μ, its width 8,3 μ, the length of curved spikes being 33-37,5 μ /Fig. 3,1/

112. *Chodatella quadriseta* L e m m .

113. *Cladophora glomerata* K ü t z ., a plant characteristic of the benthos and perifiton of the river Zagyva. It has a wide ecological valence being present, according to S l á d e č e k /1962/, from the clear /oligo-saprobical/ waters to the polluted /mezosaprobical/ ones. C h u d y b a /1965/ describes them from a river and streams of clear water /1968/, distinguishing two characteristic groups; *Cladophora* glomerata rheobenticum occours in flowing places, while *Cladophora glomerata limnobenthicum* in places without any flow. F j e r - d i n g s t a d /1950, 1967/ is characterizing with the *Cladophora* community a saprobical zone. Being a sessile organism, epifitic community develop on it - mainly diatom - described *Chudyba* /1968/ under the name of *Cladophoretum glomeratae epiphytosum rheobenthicum* C h u d y b a . An estimation of the *Chladophora* community in the river Zagyva would be reasonable even from saprobiological point of view. According to my observations, the change in pollution is well-indicated by the epifitic community on the *Cladophora*. At the passing of waste-water waves, on the *Cladophora*, *Beggiatoa alba* and *Zoogloea ramigera* settled and the frequency of *Nitzschia palea* a *Nitzschia acicularis* increased. As the pollution had ceased being, the original community reappeared.

114. *Coelastrum microporum* N ä g .

115. *Crucigenia quadrata* var. *octogona* S c h m i d l e .

116. *Crucigenia rectangularis* G a y .

117. *Crucigenia tetradedia* / K i r c h . / W. et W.

118. *Dictyosphaerium elegans* B a c h .

119. *Dictyosphaerium pulchellum* W o o d .

120. *Eudorina elegans* E h r .

121. *Gonium pectorale* E h r .

122. *Gonium sociale* W a r m .

123. *Lagermeimia wratislaviensis* S c h o e r e d , the spikes of widened basis found on the poles and on both sides of the ellipsoidal cell lie in one level. Cell size; 6-8 x 4-5 µ, the spikes being 13-15 µ long /Fig. 3, 12/.

124. *Lambertia ocellata* var. *maxima* U h e r k o v., the cell of size 140 x 14 μ is elongated spindle-shaped, narrowing at both ends /Fig. 3, 18/.

125. *Micractinium pusillum* F r e s .

126. *Oocystis lacustris* C h o d .

127. *Oocystis crassa* var. *marssonii* P r i n t z

128. *Pandorina morum* / M ü l l / B o r y .

129. *Pediastrum boryanum* M e y e n

130. *Pediastrum duplex* M e y e n

131. *Pediastrum duplex* f. *setigera* K o r s c h., on the peaks of the outer cells there are sitting two-three thin spikes of 5-14 μ length /Fig. 3, 16/

132. *Scenedesmus acuminatus* /L a g e r h ./ C h o d .

133. *Scenedesmus acutus* M e y e n

134. *Scenedesmus anomalus* / G. M. S m i t h / T i f f., cell size; 6-8 x 1,7 μ, spike 7,5-10 μ /Fig. 3, 4-5/.

135. *Scenedesmus anomalus* /G. M. S m i t h/ T i f f . varians?, the cells forming coenobium in pairs, bending outwards. Size cell; 10 x 1,7 μ, spike 9-10 μ /Fig. 3, 3/.

136. *Scenedesmus anomalus* /G. M. S m i t h/ T i f f . forma? on the ends of cells of size; 8,3 x 1,7 μ a short spike of 3-3,5 μ is sitting /Fig. 3, 6/.

137. *Scenedesmus bicaudatus* /H a n g s ./ C h o d .

138. *Scenedesmus denticulatus* L a g e r h .

139. *Scenedesmus ecornis* /R a l f s./ C h o d .

140. *Scenedesmus ellipsoideus* C h o d .

141. *Scenedesmus granulatus* W. et W.

142. *Scenedesmus intermedius* C h o d .

143. *Scenedesmus intermedius* var. *balatonicus* H o r t o b .

144. *Scenedesmus intermedius* var. *bicaudatus* H o r t o b .

145. *Scenedesmus nanus* C h o d . , cell size; 7,5 x 5 μ, spike /Fig. 3, 10/.

146. *Scenedesmus opoliensis* P. R i c h t .

147. *Scenedesmus protuberans* F r i t s c h .

148. *Scenedesmus quadricauda* /T u r p ./ B r é b./

149. *Scenedesmus quadricauda* var. *setosus* K i r c h . /Syn; Sc. *longus* M e y e n , Sc. *longus* var. *nägelii* / B r é b./

G. M. S m i t h, Sc. *nägelii* B r é b./, the coenobium consists of 4-8 cells, the cells being spindle-shaped, their ends bluntly peaked or rounded. On the poles of inner cells a straight or somewhat curved spike of changing length is sitting. Cell size: 6,7-10 x 2,5-5 μ, the length of spikes being 5-10 μ. The specimens found by me /Fig. 3, 9, 11, 14, 15/ can be classed into the form-circle of Sc. *quadricauda* var. *setosus* K i r c h., if we consider the taxons of Sc. *longus*, Sc. *longus* var. *nägelii*, Sc. *nägelii* - those their specimens where the inner cells are spiky, as well, - to be synonymic.

150. Sc. *spinosus* C h o d .

151. *Selenastrum gracile* R e i n s c h

152. *Sphaerellopsis gleocystiformis* /D i l l/ G e r l o f f, Cell size; 12 x 9 μ together with cell-membrane; 20 x 18, the flagellum being 21 μ long /Fig. 3, 17/.

153. *Spondylomorum quarternarium* E h r .

154. *Tetraedron minimum* /A. B r./ H a n s g .

155. *Tetraedron muticum* /A. B r./ H a n s g .

156. *Tetraedron glabrum* / R o l l / A h l . et T i f f .

157. *Tetrastrum staurogenieforme* /S c h o e r e d / L e m m .

*C h l o r o p h y t a - C o n j u g a t o p h y c e a e*

158. *Closterium acerosum* E h r .

159. *Closterium strigosum* B r é b .

160. *Spirogyra* sp.

161. *Staurastrum paradoxum* M e y e n

*Z o o f l a g e l l a t a*

162. *Bodo globosus* S t e i n

163. *Bodo mutabilis* K l e b s

164. *Bodo putrinus* L e m m .

165. *Bodo repens* K l e b s.

166. *Bodo saltans* E h r .

167. *Cercobodo agilis* /M o r o f f/ L e m m .

168. *Cercobodo longicauda* /S t e i n/ S e n n

169. *Desmarella moniliformis* K e n t .

170. *Hexamitus inflatus* D u j .
171. *Hexamitus pusillus* K l e b s .
172. *Monas vulgaris* /C i e n./ S e n n
173. *Oicomonas sociabilis* K e n t
174. *Tetramitus pyriformis* K l e b s
175. *Trepomonas agilis* D u j .
176. *Trepomonas rotans* K l e b s
177. *Trepomonas steinii* K l e b s
178. *Trigonomonas compressa* K l e b s

*R h i s o p o d a*

179. *Actinophris sol* E h r .
180. *Actinosphaerium echicornii* E h r .
181. *Amoeba radiosa* D u j .
182. *Arcella vulgaris* E h r .

*C i l i a t a*

183. *Aspidisca costata* C l. et L a c h .
184. *Carhesium* sp.
185. *Chilodonella cucullulus* O.F. M ü l l .
186. *Chilodonella uncinata* E h r .
187. *Chinetochilum margaritaceum* P e t r y .
188. *Coleps hirtus* N i t z s.
189. *Colpidium colpoda* S t e i n
190. *Cyclidium citrulus* C h o n
191. *Dileptus anser.* O. F. M ü l l .
192. *Euplotes charon* S t e i n
193. *Glaucoma scintillans* E h r .
194. *Halteria grandinella* E h r .
195. *Holophrya nigricans* L a u t e r .
196. *Lionotus fascicola* E h r .
197. *Loxophyllum helus* S to k .
198. *Metopus es* C l . et L o c h .
199. *Metopus contortus* L e v . ?
200. *Oxytricha fallax* S t e i n ?
201. *Paramaecium* sp.
202. *Pleuronema crassum* D u j . ?
203. *Plagyophylla nasuta* S t e i n
204. *Prorodon terres* E h r .
205. *Spirostomum ambiguum* E h r .
206. *Stentor polymorphus* E h r . - S t e oi n
207. *Stylonichia mytilus* E h r . ?
208. *Tachiosoma pellionella* M ü l l . - S t e i n

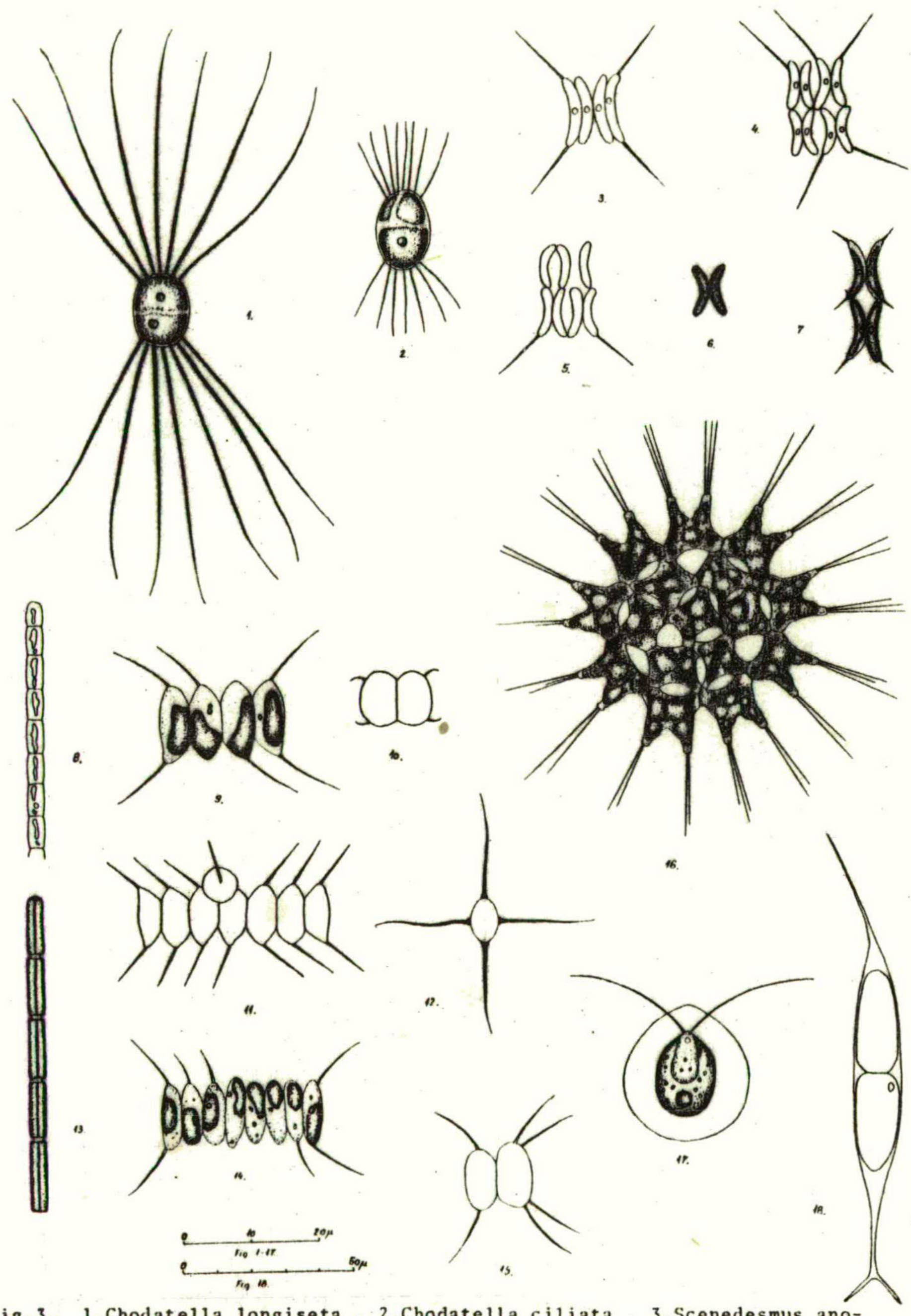


Fig.3. 1.Chodatella longiseta , 2.Chodatella ciliata , 3.Scenedesmus anomalus forma , 4.5.Scenedesmus anomalus , 6.Scenedesmus anomalus var. acaudatus , 7.Scenedesmus anomalus forma , 8.Oscillatoria lauterbornii , 9.11.14.15.Scenedesmus quadricauda var. setosus , 10.Scenedesmus nanus , 12.Lagerheimia wratislaviensis, 13.Achronema articulatum , 16.Pediastrum duplex f. setigera , 17.Sphaerellopsis gleocystiformis , 18.Lambertia ocellata var. maxima

209. *Urostyla* sp.
210. *Uronema marinum* D u j .
211. *Vorticella campanula* E h r .
212. *Vorticella convallaria* N o l a n d

Summary

The defence of our natural water supply belongs to our first-class tasks. By increasing the sources of pollution, the ability of purification in our waters decreases. That is meaning a problem, mainly in case of receivers of a small and changing water output like the river Zagyva is. The change in the degree of pollution engendered by the several and continuous waste--water intakes depends first of all on the water output of the river Zagyva. The major pollutions are caused by the seasonal waste-water disposals of the sugar-works. With chemical and biological investigations we have followed with attention the effect of the waste-water of the sugar-works on the Zagyva and found a considerable difference between the effects of the waste-water waves of the two sugar-works, caused by the different storing periods. We have reffered with a few representative examples to the chemical and biological state of the river Zagyva.

We should like to express our thanks to senior member G. U h e r k o v i c h for his professional advices, to chemist B. K o n k o l y for his kind support, and to biologist B. E r d e l i c s for his information about the upper reaches of the river Zagyva.

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References

C h u d y b a , H. /1965/ : *Cladophora glomerata* and accompayning algae in the Skawa river.- Acta Hydrobiol. 7, Suppl.1, 93-126.

C h u d y b a , H. /1968/: *Cladophora glomerata* and concomitant algae in the river Skawa. Distribution and conditions of appearance. - Acta Hydrobiol. 10, 38-84.

F j e r d i n g s t a d , E. /1950/: The microflora of river Mølleaa, with special reference to the relation of the benthal algae to pollution. - Folia Limnol. Scand. 5, 1-123.

F j e r d i n g s t a d , E. /1964/: Pollution of streams estimated by benthal phytomicro-organism. I. A saprobic system based on communities of organism and ecological factors. - Int. Rev. Hydrobiol. 49, 63-131.

G u l y á s, P. /1964/: A Zagyva hosszszelvényének szaprobiológiai vizsgálata /Saprobiological investigation of longitudinal section of the Zagyva/. - /Manuscript/.

H a m a r , J. /1967/: Szaprobiológiai vizsgálat a Zagyván /Saprobiological investigation in the Zagyva/ - /Manuscript./

H o r t o b á g y i, T. /1957/: Algák két hortobágyi halastóból /Algae from two fish-ponds in the Hortobágy/. - Yearbook of the Teachers' Training College, Eger /Hungary/ 3, 361-408.

H o r t o b á g y i, T. /1959/: Algen aus den Fischteichen von Buzsák. III. *Scenedesmus*-Arten. - Nova Hedwigia 1, 41-64.

H o r t o b á g y i, T. /1960 a/: Algen aus den Fischteichen von Buzsák. II. *Scenedesmus*-Arten. - Nova Hedwigia 1, 345-381.

H o r t o b á g y i, T. /1960 b/: Algen aus den Fischteichen von Buzsák. III. *Scenedesmus*-Arten. - Nova Hedwigia 2, 173-190.

H o r t o b á g y i, T. /1964/: A *Scenedesmus*ok konvergenciái s azok jelentősége /Convergences of the *Scenedesmus* species and their importance/. Biol.Közl. 11, 155-166.

H u b e r - P e s t a l o z z i, G. /1938-1961/: Das Phytoplankton des Süsswassers. I-V. Stuttgart.

K a h l, A. /1930-1935/: Urtiere oder *Protozoa*. I. Wimpertiere oder *Ciliata* /*Infusoria*/. - Die Tierwelt Deutschlands u.d. umgrenzenden Meeresteile. Teil 18, 21, 25, 30.- Jena.

K o r s h i k o v, O. A. /1953/: Viznatchnik prisnovodnikh vodorestei Ukranskoi RSR. V. *Protococcinae*. - Kiev.

P a s c h e r, A. /1913/: *Flagellatae*.II. P a s c h e r: Die Süsswasser-Flora Deutschlands, Österreichs u.d.Schweiz. Heft 2.-Jena.

P a s c h e r, A. /1914/: *Flagellatae*.I. P a s c h e r: Die Süsswasser-Flora Deutschlands, Österreichs u.d.Schweiz. Heft 1.-Jena.

P a n t l e, R. und H. B u c k /1955/: Biologische Überwachung der Gewässer und die Darstellung der Ergebnisse. - Gas und Wasserfach. 96, 604-609.

S l á d e č e k, V. /1963/: A guide to limnosaprobical organisms. - Technology of Water 7, 543-612.

S z e m e s, G. /1940/: Jászberény és környékének mikroszkópikus növényvilága /Microscopical flora of Jászberény and environs/, I. A Zagyva kovamoszatai /Diatoma of the Zagyva/.- Jászb. Int. Ért. 1-7.

S z e m e s, G. /1947/: A Zagyva folyó *Bacillariophyta* flórájának oikológiai vizsgálata. Quantitativ benthos analizisek /Oecological investigation of the bacillariophytic flora in the river Zagyva. Quantitative benthal analyses/. - Borbásia 7, 70-122.

S z e m e s, G. /1948/: A Zagyva folyó kovamoszatainak elterjedése a forrástól a torkolatig /Distribution of Diatom in the river Zagyva from the source till the mouth/. Borbásia 8, 89-112.

U h e r k o v i c h, G. /1961/: A tiszai algák a szaprobionta rendszerben /Algae of the Tisza in the saprobiontical system/. Hidr. Közl. 41, 85-88.

U h e r k o v i c h, G. /1964/: Das Leben der Tisza XXV. Die quantitativen, bzw. saprobiologischen Verhältnisse des Phytoplanktons im Szolnoker Flussabschnitt.- Acta Biol. 10, 147-154.

U h e r k o v i c h, G. /1966 a/: Übersicht über das Potamophytoplankton der Tisza /Theiss/ in Ungarn. - Hidrobiologia 28, 252-280.

U h e r k o v i c h, G. /1966 b/: Die *Scenedesmus*-Arten Ungarns. - Budapest.

U h e r k o v i c h, G. /1969/: Adatok a Tisza potamophytoplanktonja ismeretéhez /Data to the knowledge of the potamophytoplankton in the river Tisza/. VIII. A tiszai kékmoszatok áttekintése /A survey of blue-green algae in the river Tisza/. Hidr. Közl. 7, 331-336.

| | pH | Alkal. W° | $Ca^{++}$ mg/l | $Mg^{++}$ mg/l | $Na^{+}$ mg/l | $K^{+}$ mg/l | $Cl^{-}$ mg/l | $So_4^{--}$ mg/l | $HCo_3^{-}$ mg/l | $Po_4^{---}$ mg/l | $NH_4^{+}$ mg/l | $No_2^{-}$ mg/l | $No_3^{-}$ mg/l | $O_2$ decrease mg/l | Diss.$O_2$ mg/l | BOD 5 days mg/l | $Co_3^{--}$ mg/l | Free $Co_2$ mg/l | $H_2S$ mg/l | Biol. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Pure | 7.3 | 7.2 | 107 | 51,1 | 71,5 | 14,7 | 55,0 | 209 | 439 | 0,67 | Ø | 0,03 | 10,3 | 2,04 | 14,0 | 5,92 | Ø | 0,96 | Ø | β-α |
| 2. Polluted | 8,5 | 7,6 | 93,8 | 84,1 | 76,0 | 34,0 | 71,1 | 265 | 463 | 2,00 | 0,3 | Ø | 6,3 | 5,24 | 7,36 | 8,74 | 24,0 | Ø | Ø | α |
| 3. Strongly polluted | 8,1 | 11 | 112 | 52,0 | 90,0 | 20,5 | 46,1 | 129 | 671 | 0,67 | 5,1 | 0,03 | 0,76 | 62,4 | Ø | 116,5 | 6,oo | Ø | trace | p |

Table 1. Various pollution of the river Zagyva

Legend: 1. Jászfényszaru Apr. 24 1968
2. Jászfényszaru Apr. 30 1968
3. Jászfényszaru Sept.20 1967

Table 2. Biological evaluation of the waste-water wave from the sugar-works in Selyp

| Sample areas November 2nd 1967 | | 1. The Zagyva below Selyp | | 2. Storage pond of the sugar-works in Selyp | | 3. The Zagyva at Jászfényszaru | | 4. The Zagyva at Jászberény | | 5. The Zagyva at Jásztelek | | 6. The Zagyva at Ujszász | | 7. The Zagyva at Szolnok | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Microorganisms | s | h | s.h | h | sh | h | s.h | h | s.h | h | s.h | h | s.h | h | s.h |
| Coccus | 4 | | | 5 | 20 | 5 | 20 | 5 | 20 | 5 | 20 | 5 | 20 | 5 | 20 |
| Streptococcus margaritaceus | 4 | | | 3 | 12 | | | | | | | | | | |
| Filamentous bac. | 4 | | | 5 | 20 | 3 | 12 | 5 | 20 | 5 | 20 | 5 | 20 | 5 | 20 |
| Zoogloea ramigera | 4 | | | | | | | | | 3 | 12 | 3 | 12 | 3 | 12 |
| Beggiatoa alba | 4 | | | | | | | 3 | 12 | 5 | 20 | 5 | 20 | 5 | 20 |
| Oscillatoria chlaybea | 3 | | | | | | | | | 3 | 9 | 3 | 9 | 3 | 9 |
| Euglena viridis | 4 | | | 3 | 12 | | | | | | | | | | |
| Melosira varians | 2 | 3 | 6 | | | | | | | | | | | | |
| Synedra ulna | 2 | 5 | 10 | | | | | | | | | | | | |
| Achnantes minutissima | 2 | 3 | 6 | | | | | | | | | | | | |
| Nitzschia palea | 3,5 | | | | | | | | | | | 5 | 17,5 | 5 | 17,5 |
| Anthophysa vegetans | 3,5 | | | | | | | 3 | 10,5 | 3 | 10,5 | 3 | 10,5 | 3 | 10,5 |
| Bodo putrinus | 4 | | | 1 | 4 | 3 | 12 | | | | | | | | |
| Bodo saltans | 3 | 1 | 3 | | | | | | | | | | | | |
| Cercobodo longicauda | 4 | | | 5 | 20 | | | 5 | 20 | 5 | 20 | 5 | 20 | 5 | 20 |
| Oicomonas sociabilis | 4 | | | 3 | 12 | 5 | 20 | 5 | 20 | 5 | 20 | 5 | 20 | 5 | 20 |
| Aspidisca costata | 2 | 3 | 6 | | | | | | | | | | | | |
| Glaucoma scintillans | 3,5 | 1 | 3,5 | | | | | | | | | | | | |
| Σ | | 17 | 34,5 | 25 | 100 | 16 | 64 | 26 | 10,25 | 32 | 12,35 | 37 | 141 | 37 | 141 |
| S | | 2,0 | | 4,0 | | 4,0 | | 3,9 | | 3,85 | | 3,8 | | 3,8 | |
| Biological evaluation | | β | | p | | p | | p | | p | | p | | p | |

Table 3. Biological evaluation of the waste-water wave from the sugar-works in Hatvan.

| Sample areas April 30th 1968 | | 1. Zagyva at Hatvan | | 2. Storage pond of the sugar-works in Hatvan | | 3. Zagyva below the sugar-works | | 4. Zagyva at Jászfényszaru | | 5. Zagyva at Jásztelek | | 6. Zagyva at Ujszász | | 7. Zagyva at Szolnok | | 8. Zagyva at Szolnok March 29th 1969 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Microorganisms | s | h | s.h | h | s.h | h | s.h | h | s.h | h | s.h | h | s.h | h | s.h | h | s.h |
| Coccus | 4 | | | 3 | 12 | 3 | 12 | 3 | 12 | | | | | | | 3 | 12 |
| Filamentous bac. | 4 | | | 3 | 12 | 3 | 12 | 3 | 12 | | | | | | | 3 | 12 |
| Zoogloea ramigera | 4 | | | 1 | 4 | | | | | | | | | | | | |
| Sphaerotilus natans | 4 | | | | | | | | | | | | | | | 1 | 4 |
| Beggiatoa alba | 4 | | | 3 | 12 | | | | | | | | | | | 3 | 12 |
| Thiovolum sp. | 4 | | | 1 | 4 | 1 | 4 | | | | | | | | | | |
| Oscillatoria chlorina | 3,5 | | | 1 | 3,5 | 3 | 10,5 | | | | | | | | | | |
| Oscillatoria lauterbornii | 4 | | | | | | | | | | | | | | | 1 | 4 |
| Euglena proxima | 2 | 1 | 2 | | | | | | | 3 | 6 | 1 | 2 | | | | |
| Peranema trichophorum | 3 | | | 1 | 3 | 1 | 3 | | | | | | | | | | |
| Cyclotella meneghiniana | 2 | 1 | 2 | | | | | | | 1 | 2 | 3 | 6 | 5 | 10 | 1 | 2 |
| Melosira granulata | 2 | | | | | | | 1 | 2 | | | | | 1 | 2 | | |
| Synedra ulna | 2 | 1 | 2 | | | | | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | | |
| Navicula cryptocephala | 2,5 | | | | | | | 3 | 7,5 | | | | | | | 1 | 2,5 |
| Nitzschia acicularis | 2,5 | 3 | 7,5 | | | 1 | 2,5 | 5 | 12,5 | 5 | 12,5 | 5 | 12,5 | 3 | 7,5 | | |
| Nitzschia palea | 3,5 | 3 | 10,5 | 3 | 10,5 | 3 | 10,5 | 3 | 10,5 | 3 | 10,5 | 1 | 3,5 | 1 | 3,5 | 3 | 10,5 |
| Nitzschia sigmoidea | 2,5 | | | | | | | 1 | 2,5 | 1 | 2,5 | 1 | 2,5 | | | | |
| Nitzschia tryblionella | 2 | | | | | | | | | 1 | 2 | | | 3 | 6 | | |
| Cymatopleura solea | 2 | 1 | 2 | | | | | | | 1 | 2 | | | | | | |
| Eudorina elegans | 2,5 | | | | | | | | | 1 | 2,5 | 1 | 2,5 | 1 | 2,5 | | |
| Pediastrum duplex | 2 | | | | | | | | | | | | | 1 | 2 | | |
| Richteriella botryoides | 2 | | | | | | | 1 | 2 | 3 | 6 | 3 | 6 | 5 | 10 | | |
| Ankistrodesmus falcatus | 2 | 1 | 2 | | | | | 1 | 2 | 3 | 6 | 3 | 6 | 3 | 6 | | |
| Actinastrum hantzschii | 2 | 1 | 2 | | | | | 1 | 2 | 3 | 6 | 5 | 10 | 5 | 10 | | |
| Scenedesmus acuminatus | 2 | 1 | 2 | | | | | | | | | 1 | 2 | 1 | 2 | | |
| Scenedesmus quadricauda | 2 | 1 | 2 | | | | | 1 | 2 | 1 | 2 | 3 | 6 | 3 | 6 | | |
| Cercibodo longicauda | 4 | | | 1 | 4 | | | | | | | | | | | | |
| Monas vulgaris | 3,5 | | | | | | | | | | | 1 | 3,5 | | | | |
| Oicomonas sociabilis | 4 | | | | | 3 | 12 | 3 | 12 | | | | | | | | |
| Anthophysa vegetans | 3,5 | | | | | 1 | 3,5 | | | | | | | | | | |
| Bodo globosus | 3 | 3 | 9 | | | 1 | 3 | | | | | | | | | | |
| Bodo putrinus | 3 | | | 1 | 3 | 1 | 3 | | | | | | | | | | |

| Sample areas April 30th 1968 | | 1. Zagyva at Hatvan | | 2. Storage pond of the sugar-works in Hatvan | | 3. Zagyva below the sugar-works | | 4. Zagyva at Jász-fényszaru | | 5. Zagyva at Jász-telek | | 6. Zagyva at Uj-szász | | 7. Zagyva at Szolnok | | 8. Zagyva at Szolnok March 29th 1969 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Microorganisms | s | h | s.h | h | s.h | h | s.h | h | s.h | h | s.h | h | s.h | h | s.h | h | s.h |
| Tetramitus pyriformis | 4 | | | 1 | 4 | | | | | | | | | | | | |
| Trigonomonas compressa | 4 | | | 1 | 4 | | | | | | | | | | | | |
| Actinosphaerium echicornii | 2,5 | 3 | 7,5 | | | | | | | | | | | 3 | 7,5 | | |
| Amoeba radiosa | 2,5 | | | | | | | | | | | | | | | 1 | 2,5 |
| Chilodonella cucullulus | 3 | | | | | | | 1 | 3 | | | | | | | | |
| Metopus es | 4 | | | | | | | | | 1 | 4 | | | | | | |
| Coleps hirtus | 2,5 | 1 | 2,5 | | | | | 1 | 2,5 | | | | | | | | |
| Stylonichia mytilus | 2,5 | 1 | 2,5 | | | | | | | | | | | | | | |
| | | 22 | 55,5 | 20 | 75,5 | 21 | 76 | 30 | 88,5 | 29 | 68 | 29 | 64,5 | 36 | 77 | 17 | 61,5 |
| | | | | | | | | | | | | | | | | | |
| Biological evaluation | | | | | | | | | | | | | | | | | |