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Benthic Diatom Distribution in the Cedar River Basin, Iowa

STEPHEN P. MAIN


Counting approximately 500 diatoms from each of 16 benthic diatom samples collected 11 October 1975 from the Cedar River and its tributaries, the Shell Rock and Little Cedar Rivers, in NE Iowa has yielded 118 taxa. These waters were alkaline (160-210 ppm HCO₃, pH 8.4-9.5), turbidity was negligible in the Little Cedar and rose to 40 FTU in the Cedar. The 5 most abundant taxa and their distributions were: Stephanodiscus subtilis (Van Goor) A. Cleve, more than 40% of the 2 Shell Rock samples and rare in the 4 Little Cedar samples; Cyclotella meneghiniana Kütz., found in all samples (3%-26%) but most abundant in Cedar River samples; Diatoma vulgaris Bory, associated mostly with epiphytic samples; Skeletonema potamos (Weber) Hasle, most abundant in Cedar River samples; and Nitzschia acicularis (Kütz.) W. Sm., present in all samples and over 50% of one sediment sample from the Little Cedar.

The widespread occurrence of Cyclotella meneghiniana and the scattered appearance of samples dominated by one taxon is suggestive of the presence of organic or other pollutants. Seasonal sampling of this diatom flora at these stations and others is continuing.

INDEX DESCRIPTORS: diatom, river, benthic, Cedar River.

METHODS AND MATERIALS

Benthic diatoms are being sampled at 14 locations in the Cedar River drainage basin. All stations are located on the Cedar River or one of its tributaries (Figure 1). These stations are numbered in the sequence in which they are sampled during a one day collecting trip. The results reported here represent a preliminary determination of variation in diatom species occurrence and abundance at those stations closest to Waverly, Iowa. Samples are being collected in October, February, May and August of each year.

The six stations reported in this paper and the samples collected from them are described briefly in Table 1. The station farthest down river (no. 13) is located at the Washington-Union access area along the Cedar River about 1.2 km below its confluence with the West Fork of the Cedar River. The Shell Rock River joins the West Fork near this confluence also. Station 10 is located on the Shell Rock River a few meters downstream from the bridge in downtown Shell Rock, approximately 11 km above the river mouth. Stations 14, 1 and 2 proceed successively up the Cedar River from the West Fork. Station 14 is a few meters downstream from the 3rd St. SE bridge in Waverly. Station 1 is on the south shore of the river bend at Cedar Bend Park (Bremer County) and station 2 is about 25 m downstream from the Iowa Highway 188 bridge east of Plainfield. Station 1 lies about 7 km above no. 14 and station 2 is about 13 km above no. 1. The Waverly reservoir separates stations 1 and 2. Station 3 is below a country bridge northeast of Nashua on the Little Cedar River about 1-2 km above its confluence with the Cedar River and 16-18 km above station 2.

Specific descriptions of benthic diatoms of the Cedar River and its tributaries in northeast Iowa do not appear to have been published previously. This is in marked contrast to the series of publications in the Proceedings of the Iowa Academy of Science by John Dodd and his associates describing the diatom flora of central and western Iowa waters. There are several published and unpublished reports, done for governmental agencies or industrial companies, regarding water quality in the portion of the Cedar River Basin dealt with in this paper. However, most of these reports describe planktonic rather than benthic diatom occurrence.

The purpose of this study is to document variations in the benthic diatom flora resulting from characteristics of the water in different tributaries and the effects of municipalities and other activities of man along the Cedar River.

A sandy mud bottom prevails at all Cedar River stations with the exception of 14 (small to large rocks) and 2 (gravel). Station 10 on the Shell Rock is rocky, while sand predominates at station 3 of the Little Cedar. All samples were collected from less than 10 cm water depth which was usually near shore.

Samples were collected from bottom sediments and submerged rocks by suction using a large pipette with a rubber bulb. Epiphytic samples were collected by hand. After microscopic examination to note which diatoms were living and to identify other algae in the samples, the diatoms were cleaned by boiling in nitric acid. Rinsed diatoms were mounted in Hyrax; unmounted portions of the samples were preserved in formalin and stored in sealed vials.

Diatom counts of 500 per slide were made by scanning slides using an 1000X oil immersion lens. Simultaneously with diatom samples, water samples were collected...
from immediately beneath the surface. Determinations of temperature, pH, CO₂, and O₂ were made at the time of collection. Samples were refrigerated in glass bottles until color, turbidity, alkalinity, nitrate, total phosphate, orthophosphate, and silica tests could be made. All tests were made using a Hach DR-EL water test set (Hach Chemical Co., Ames, Iowa).

RESULTS

On 11 October 1975, 16 samples were collected from the 6 stations (Table 1). These included 5 samples of material closely associated with sediments (13A, 1C, 2A, 3A, 3B), 4 samples from rock surfaces (10B, 14A, 1A, 1B), and 7 ephiphytic samples (10A, 14B, 14C, 3C, 3D) including 2 from woody substrates (13B, 2B).

The most abundant diatom was Stephanodiscus subtilis (Van Goor) A.Cl. (Table 2). Specimens of this taxon are 10-15 μm in diameter and have radiate striae. However, they are weakly silicified and neither the striae nor the hyaline interstices are visible toward the middle of the valve. Most abundant in the Shell Rock River samples and barely present in the Little Cedar River samples, this taxon exhibited no substrate preference.

Most taxa appeared at all stations but a few had distribution patterns restricted to certain groups of stations or showed substrate preferences (Table 2). Cyclotella meneghiniana Kutz., and Skeletonema potamos (Wether) Hasle tended to be most abundant in Cedar River samples. Cyclotella atomus Hust. and C. pseudostelligera Hust. were less abundant in the Little Cedar River than they were elsewhere, whereas Melosira varians Agardh was more abundant there. Navicula viridula var. rostellata (Kutz.) Cl. and N. cryptocephala Kutz. were absent from the Shell Rock River samples but found at all other stations. Diatom taxa occurring more frequently in ephiphytic samples than in other benthic samples included Diatomula vulgaris Bory, Nitzschia dissipata (Kutz.) Grun., Navicula cryptocephala var. veneta (Kutz.) Rabb., Cocconeis pediculus Ehr., Rhocosphenia curvata (Kutz.) Grun. ex Rabb., and the species of Gomphonema. The remainder grew more abundantly on non-living benthic surfaces, except for a few taxa which showed no preferences, such as Nitzschia acicularis (Kutz.) W. Sm., Navicula salinarum var. intermedia (Grun.) Cleve, and perhaps N. cryptocephala and Amphora perpusilla (Grun.) Grun. Not enough specimens of most of the remaining taxa have been observed to make any reasonable generalizations.

DISCUSSION

The weather for several weeks preceding 11 October 1975 had been free of rain and often sunny. With reduced run-off and erosion, water conditions in the rivers should have been optimum. The cool, clear weather and water should favor diatom growth. Therefore, the diatoms sampled should represent an “ideal” fall flora. This assumption excludes possible effects of pollutants from point sources.

The stations on the Little Cedar and Shell Rock Rivers were distinguished by several features. The physical and chemical characteristics of the water suggest that these tributaries are clearer and more nutrient-enriched than the Cedar River. However, the only samples having 40% or more of the individual diatoms counted belonging to one species were at these stations (3A and 3C: Diatomula vulgaris; 3B: Nitzschia acicularis; and Stephanodiscus subtilis at 10A and 10B).

This situation at the Little Cedar station may be related to the probable presence of organic enrichment. Just above station 3, the Little Cedar flows through a pasture and cattle wade across the river which is less than 1 m deep at normal flow. Whether or not organic nutrient levels are high in the Shell Rock River near station 10 is not known. However, it might be interesting to monitor dissolved organic levels at all stations.

Previous research (Bradbury, 1973) suggests that Cyclotella meneghiniana occurs frequently in waters that are organically or...
Table 1. Benthic Diatom Sample Descriptions, Cedar River Basin, 11 October 1975.

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Location</th>
<th>Substrate</th>
<th>Number of Diatoms Counted</th>
<th>Number of Taxa Counted</th>
</tr>
</thead>
<tbody>
<tr>
<td>13A</td>
<td>Cedar River Washington-Union Access</td>
<td>flocculent mass on bottom</td>
<td>516</td>
<td>28</td>
</tr>
<tr>
<td>13B</td>
<td>Cedar River Washington-Union Access</td>
<td>submerged roots</td>
<td>514</td>
<td>31</td>
</tr>
<tr>
<td>10A</td>
<td>Shell Rock River Bridge, Shell Rock, Iowa</td>
<td>Cladophora epiphytes</td>
<td>513</td>
<td>24</td>
</tr>
<tr>
<td>10B</td>
<td>Shell Rock River Bridge, Shell Rock, Iowa</td>
<td>silt on rocks</td>
<td>512</td>
<td>26</td>
</tr>
<tr>
<td>14A</td>
<td>Cedar River 3rd St. Bridge, Waverly</td>
<td>sediment crust on rocks</td>
<td>512</td>
<td>27</td>
</tr>
<tr>
<td>14B</td>
<td>Cedar River 3rd St. Bridge, Waverly</td>
<td>Cladophora epiphytes</td>
<td>513</td>
<td>32</td>
</tr>
<tr>
<td>14C</td>
<td>Cedar River 3rd St. Bridge, Waverly</td>
<td>deteriorating Cladophora</td>
<td>516</td>
<td>35</td>
</tr>
<tr>
<td>1A</td>
<td>Cedar River Cedar Bend Park</td>
<td>silt on rocks</td>
<td>516</td>
<td>44</td>
</tr>
<tr>
<td>1B</td>
<td>Cedar River Cedar Bend Park</td>
<td>sediment crust on rocks</td>
<td>522</td>
<td>38</td>
</tr>
<tr>
<td>1C</td>
<td>Cedar River Cedar Bend Park</td>
<td>bottom silt</td>
<td>516</td>
<td>43</td>
</tr>
<tr>
<td>2A</td>
<td>Cedar River Plainfield Bridge</td>
<td>bottom silt</td>
<td>507</td>
<td>35</td>
</tr>
<tr>
<td>2B</td>
<td>Cedar River Plainfield Bridge</td>
<td>submerged branch</td>
<td>511</td>
<td>37</td>
</tr>
<tr>
<td>3A</td>
<td>Little Cedar River NE Nashua</td>
<td>flocculent mass on bottom</td>
<td>519</td>
<td>35</td>
</tr>
<tr>
<td>3B</td>
<td>Little Cedar River NE Nashua</td>
<td>sediment crust</td>
<td>511</td>
<td>39</td>
</tr>
<tr>
<td>3C</td>
<td>Little Cedar River NE Nashua</td>
<td>Oedogonium epiphytes</td>
<td>516</td>
<td>39</td>
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<tr>
<td>3D</td>
<td>Little Cedar River NE Nashua</td>
<td>Cladophora epiphytes</td>
<td>515</td>
<td>42</td>
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</tbody>
</table>

Table 2. The 31 most abundant benthic diatom taxa collected from the Cedar River Basin, 11 October 1975, and their abundance in each sample. See Table 1 for sample descriptions. Values given are the number counted in each sample. + means present but not included in count. See Appendix for full list of distributions of all taxa.

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Samples</th>
<th>13A</th>
<th>13B</th>
<th>10A</th>
<th>10B</th>
<th>14A</th>
<th>14B</th>
<th>14C</th>
<th>1A</th>
<th>1B</th>
<th>1C</th>
<th>2A</th>
<th>2B</th>
<th>3A</th>
<th>3B</th>
<th>3C</th>
<th>3D</th>
<th>Total</th>
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<tbody>
<tr>
<td>Stephanodiscus subtilis</td>
<td></td>
<td>108</td>
<td>159</td>
<td>229</td>
<td>236</td>
<td>168</td>
<td>141</td>
<td>95</td>
<td>102</td>
<td>89</td>
<td>92</td>
<td>75</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1514</td>
</tr>
<tr>
<td>Cyclotella meneghiniana</td>
<td></td>
<td>71</td>
<td>113</td>
<td>45</td>
<td>81</td>
<td>126</td>
<td>62</td>
<td>144</td>
<td>80</td>
<td>94</td>
<td>121</td>
<td>94</td>
<td>80</td>
<td>13</td>
<td>15</td>
<td>14</td>
<td>29</td>
<td>1182</td>
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<tr>
<td>Diatoma vulgaure</td>
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<td>0</td>
<td>0</td>
<td>83</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>17</td>
<td>2</td>
<td>+</td>
<td>2</td>
<td>1</td>
<td>237</td>
<td>8</td>
<td>273</td>
<td>33</td>
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<tr>
<td>Skeletonema potamos</td>
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<td>0</td>
<td>73</td>
<td>28</td>
<td>28</td>
<td>81</td>
<td>16</td>
<td>105</td>
<td>111</td>
<td>67</td>
<td>4</td>
<td>17</td>
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<td>0</td>
<td>557</td>
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<tr>
<td>Nitzschia acicularis</td>
<td></td>
<td>35</td>
<td>+</td>
<td>8</td>
<td>12</td>
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<td>17</td>
<td>68</td>
<td>276</td>
<td>2</td>
<td>7</td>
<td>509</td>
</tr>
<tr>
<td>Nitzschia dissipata</td>
<td></td>
<td>11</td>
<td>46</td>
<td>9</td>
<td>6</td>
<td>10</td>
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<td>4</td>
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<td>20</td>
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<td>64</td>
<td>401</td>
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<td>Stephanodiscus tenuis</td>
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<td>26</td>
<td>11</td>
<td>55</td>
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<td>33</td>
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<td>26</td>
<td>22</td>
<td>15</td>
<td>13</td>
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<td>Cyclotella atomus</td>
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<td>48</td>
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<td>20</td>
<td>16</td>
<td>37</td>
<td>29</td>
<td>17</td>
<td>34</td>
<td>23</td>
<td>4</td>
<td>10</td>
<td>5</td>
<td>4</td>
<td>302</td>
</tr>
<tr>
<td>Cyclotella pseudostelligera</td>
<td></td>
<td>1</td>
<td>30</td>
<td>6</td>
<td>21</td>
<td>22</td>
<td>24</td>
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<td>40</td>
<td>39</td>
<td>33</td>
<td>23</td>
<td>25</td>
<td>2</td>
<td>7</td>
<td>1</td>
<td>3</td>
<td>302</td>
</tr>
<tr>
<td>Nitzschia subcapitellata</td>
<td></td>
<td>87</td>
<td>13</td>
<td>7</td>
<td>13</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>21</td>
<td>12</td>
<td>7</td>
<td>36</td>
<td>11</td>
<td>34</td>
<td>32</td>
<td>5</td>
<td>3</td>
<td>292</td>
</tr>
<tr>
<td>Navicula viridula var. rostellata</td>
<td></td>
<td>43</td>
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<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>10</td>
<td>5</td>
<td>9</td>
<td>21</td>
<td>4</td>
<td>17</td>
<td>39</td>
<td>15</td>
<td>21</td>
<td>198</td>
</tr>
<tr>
<td>Cocconeis pediculus</td>
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<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>20</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>27</td>
<td>117</td>
<td>176</td>
<td></td>
</tr>
<tr>
<td>Navicula salinarum var. intermedia</td>
<td></td>
<td>14</td>
<td>16</td>
<td>14</td>
<td>13</td>
<td>5</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>15</td>
<td>5</td>
<td>9</td>
<td>7</td>
<td>7</td>
<td>5</td>
<td>+</td>
<td>3</td>
<td>137</td>
</tr>
</tbody>
</table>

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Agriculturally enriched. It is also reported to be a late summer form. It will be interesting to see if it is as abundant in future samples as in this study. Lowe (1974) indicates that *Skeletonema potamos* is considered to be nearly as pollution tolerant as *C. meghiniana*.

With the exception of the unidentified *Gomphonema* sp., the only diatoms represented by more than 30 individuals in this study but not previously reported from Iowa are *Gomphonema tergestinum* (Grun.) Fricke, *Skeletonema potamos*, *Stephanodiscus subtilis* and *S. tenuis* Hust. The last two taxa closely resemble *S. inquisitatus* Hohn and Helleman and *S. hantzschii* Grun., respectively, both of which have been reported from Iowa. *Skeletonema potamos* is a very small diatom (2-3µm diam.) of widespread occurrence and variable morphology (Hasle and Evensen, 1976). It is seen in girdle view and may be easily ignored or destroyed in preparation.

Other, less abundant, taxa not previously reported in Iowa, but included in the Appendix for this paper include *Coccosidiscus lacustris* Grun., *Gomphonema clevei* Fricke, *Melosira distans* (Ehr.) Kutz., *M. distans* var. *lirata* (Ehr.) Bethe, *Navicula protracta* forma *subcapitata* (Wisl. et Por.) Hust., *Nitzschia elegans* Hust., and *N. linkei* Hust. These are tentative designations based on examination of only a very few specimens and have not been confirmed.

Of the diatoms now reported from the Cedar River basin, all of those listed in Lowe (1974) are described as alkaliphilous or alkalibionic. One of these designations should also apply to the rest of those found here considering the chemistry of these waters. A few of the taxa observed have been more often associated with plankton rather than periphyton. Lowe (1974) lists *Cyclotella glomerata*, *Nitzschia acicularis*, and *Skeletonema potamos* as planktomic and all *Stephanodiscus* species are so designated. *Nitzschia acicularis* was easily observed in living samples, characterized by healthy plastids and active motility. The centric taxa were less easily distinguished from one another in the living condition, but most centrics observed appeared healthy. *N. acicularis* has also been found in other benthic habitats in Iowa (Fee, 1967; Lowe, 1972; Edwards and Christensen, 1972). In previous Iowa studies *Cyclotella pseudostelligera* and *Navicula rhynchocephala* var. *germainii* (Wallace) Patr. have only been reported from plankton (Gudmundson, 1972). While seeding from the plankton is not ruled out, my evidence suggests many of these taxa previously described as plankton are functional members of the benthic communities sampled. In other words, they are physiologically active when in surface films as well as when suspended in water.

The areas of the Cedar River and its tributaries studied have alkaline waters of moderate inorganic nutrient levels and variable turbidity. The possibility of organic and agricultural enrichment exists. The benthic diatom flora is representative of that found in Iowa surface waters in other drainage basins. Most samples had large numbers of species but, very few species of high relative abundance. The observation of higher turbidity in the Cedar River than in its tributaries suggests one experimental approach to determining a cause, if any, for corresponding variations in abundances of certain species of *Cyclotella* and *Navicula*. The response of diatom distributions to point sources of organic and inorganic pollutants also requires closer examination. Some of this information could be provided by the continuation of this study.

**ACKNOWLEDGEMENTS**

Appreciation is expressed to my wife, Elaine, who assisted in much of the collecting and water analysis, and to Wartburg College for financial support through faculty research grants. Additional thanks go to Dr. John Dodd for much useful advice, to Dr. Charles Reimer and Dr. Eugene Stoeiner for taxonomic assistance, and to Dr. Barbara Gudmundsen for initial encouragement.
Appendix: Diatom taxa observed or counted in samples from the Cedar River and some of its tributaries, 11 October 1975. Values given are percentages; + indicates present but not included in count; −1 signifies less than 1%.

<table>
<thead>
<tr>
<th>Station</th>
<th>13</th>
<th>14</th>
<th>Station</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>Achnanthes:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>clevei Grun.</td>
<td>+</td>
<td></td>
<td>-1</td>
</tr>
<tr>
<td>deflexa Reim.</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>hauckiana var. rostrata Schulz</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>hungarica (Grum.) Grun.</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lanceolata (Breb.) Grun.</td>
<td>-1</td>
<td>+</td>
<td>-1</td>
</tr>
<tr>
<td>lanceolata var. dubia Grun.</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>minutissima Kutz.</td>
<td>+</td>
<td></td>
<td>-1</td>
</tr>
<tr>
<td>Amphora:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>perpusilla (Grum.) Grun.</td>
<td>-1</td>
<td>-1</td>
<td>-1</td>
</tr>
<tr>
<td>submontana Hust.</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caloneis ventricosa var.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>minuta (Grum.) Patr.</td>
<td>-1</td>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>Cocconeis:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pediculus Ehr.</td>
<td>-1</td>
<td>-1</td>
<td>4</td>
</tr>
<tr>
<td>placenta Ehr.</td>
<td>-1</td>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>placenta var. euglypta (Ehr.) Cleve</td>
<td>+</td>
<td></td>
<td>-1</td>
</tr>
<tr>
<td>Coscinodiscus lacustris Grun.</td>
<td>-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyclotella:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>atomus Hust.</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
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