Life cycle of the net-spinning caddisfly, *Cheumatopsyche analis* (Banks) (Trichoptera: Hydropsychidae), in two small Front Range urban streams, Fort Collins, Colorado

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The filter-feeding caddisflies of the family Hydropsychidae are well-known members of most stream communities throughout North America (Wiggins 1996). Often they comprise a substantial portion of aquatic insect biomass in streams, especially in relation to secondary production (Benke and Wallace 1980, Wallace and Merritt 1980, Parker and Voshell 1983, Smock and Roeding 1986, Bowles and Allen 1991). Larvae of the hydropsychid genus Cheumatopsyche are common in warm-water streams with moderate to high organic loads (Wallace 1975, MacKay 1986). One species, C. analis (Banks), occurs over much of southern Canada and the U.S. (Gordon 1974). This species tolerates a broad range of lotic habitats and stream temperatures (Gordon and Wallace 1975, MacKay 1986, Kondratieff et al. 1997). Along the eastern Front Range of the Rocky Mountains of Colorado, C. analis is often the dominant net-spinning caddisfly, especially in the transition zone where streams meet the Great Plains. In fact, C. analis is often the only caddisfly species present in many regional small streams (Zuellig 2001). Herrmann et al. (1986) also reported C. analis to be a particularly common species in Colorado.

Despite the recent focus on studying the ecology of urban streams, very few studies have described life cycles of aquatic insects from urban systems (Paul and Meyer 2001). In this paper we describe the life cycle of C. analis from 2 small urban streams located in Fort Collins, Colorado. Both streams are influenced by stormwater runoff and other typical stream alterations associated with urban development, thus providing a unique opportunity to examine the life history of this species in an urban lotic system.

METHODS

Study Area

The study area is located in north central Colorado within the city limits of Fort Collins, which is situated in the northwest central portion of the South Platte River basin (Fig. 1). Fort Collins is a moderately sized urban area (ca. 119,000 residents) that sits approximately 6.5 km from the eastern edge of the Rocky Mountains. Dennehay et al. (1993) provides a detailed description of the environmental setting of the study area and the surrounding South Platte River basin. Typically, soils consist of cobbly clay loam, clay loam, or gravelly sandy clay. The depth to bedrock is usually >1.5 m (Dennehay et al. 1993). Annual precipitation is <38 cm. Several authors have documented changes that
have occurred across the landscape that began in the early 1800s (Eschner et al. 1983, Wohl 2001).

We chose 1 site on each of 2 perennial streams, Mail Creek and Spring Creek, for analysis as part of a larger study that investigated the effects of urban stream habitat on aquatic communities (Zuellig 2001). Both streams are tributaries to the Cache la Poudre River (Fig. 1). The Spring Creek and Mail Creek basins are relatively small, draining a total area of 5800 ha and 648 ha, respectively. Both streams are in close proximity to each other and both sites are at similar elevations. The Spring Creek site was located at a city park in the lower part of the basin (40°33′59″N, 105°02′10″W, elevation 1515 m). The Mail Creek site was located at a small business park.
in the upper part of the basin (40°31′23″N, 105°04′52″W, elevation 1547 m). Both streams have been incorporated into extensive irrigation canal networks, which began in the 1860s (Eschner et al. 1983). Water from the Cache la Poudre River and other adjacent basins is transported laterally across several basins into both streams. The main purpose for these lateral water transfers is to provide water for irrigated agriculture on the eastern plains of Colorado. Both sites are subject to stormwater runoff and other typical practices associated with urbanization such as channelization and riparian zone removal.

Sample Collecting and Processing

We collected benthic macroinvertebrate samples at each site from riffle areas using a kick net with an opening of 25 × 45 cm equipped with a 500-µm mesh net. The kick net was placed on the streambed, and the substrate was disturbed and rubbed clean of any invertebrates for a period of 1 minute by a collector moving in an upstream direction. Samples were collected from August 1999 through August 2000 every 15 days during spring, summer, and fall and once every 30 days during the winter. Because of excessive ice cover at both sites, we did not collect samples in January. Samples were fixed in the field using a 5% formaldehyde solution and transported to the laboratory for processing.

At the laboratory, stream samples were washed through a 500-µm sieve and were then spread evenly into a white enamel pan. All Cheumatopsyche larvae were removed from each sample, placed into storage vials, and preserved in 80% ethanol. We measured head capsule width using a dissecting microscope equipped with an ocular micrometer calibrated to the nearest 0.01 mm.

We also collected adult caddisflies along stream margins at each site using a sweep net, and these were preserved in 80% ethanol. Adult specimens and mature pupae were identified in the laboratory following Gordon (1974) and sent to David E. Ruiter for verification. Gordon (1974) considered the name analis as a nomina dubia and resurrected the name pettiti for C. analis (Flint and England 2003). Recently, Flint and England (2003) placed C. pettiti as a junior synonym to C. analis. Adult specimens were deposited in the C.P. Gillette Museum of Arthropod Diversity (CSUC), Colorado State University, Fort Collins, Colorado.

Data Analysis

Larval instars were determined by plotting size frequency distributions of head capsule width to obtain width ranges for instars I through V for each site. Larvae were assigned instar size, and head capsule width was plotted to visually assess instar variability between sites. We also compared mean head capsule width from these populations with means of other populations from the literature. Size frequency distribution diagrams were constructed for each site based on the relative percent of the total number of individuals at each instar collected each month.

RESULTS

Keys for species identification of immature Cheumatopsyche larvae are currently unavailable; however, all adults collected from the stream margins during this study were verified as C. analis. Therefore, we are confident the larvae measured in this study were those of C. analis. Head width measurements from 8652 larvae were used to determine the distribution of the mean and the range of head capsule width across instars at both sites (Table 1). Variability in head capsule width at both sites increased as larvae increased in size. Mean head capsule width of instars I through III from these 2 urban streams was similar to others reported in the literature; however, mean head capsule width of instars IV and V from these 2 urban populations was often slightly larger than other populations.

The life cycle of C. analis in these 2 urban streams was strikingly similar, appearing to be partially bivoltine with a long period of recruitment from June through September (Fig. 2). Pupae were first observed in April and were present until September except for a 2-week period in June in both streams. The presence of pupae in both streams from late April through September (Fig. 2) coincides with Herrmann et al. (1986) and with C. analis records at CSUC from northern Colorado and southern Wyoming streams. Large numbers of adults were observed along stream margins during May and June, which we estimate as peak emergence for the early generation. Some
of the pupae present in late August are probably offspring from individuals that emerged at the beginning of emergence in May. The remainder that did not emerge in September probably overwintered as instars IV or V. The timing of the presence of large numbers of adults seemed to be identical at both sites even though most of the Spring Creek population overwintered as instars IV or V; whereas, the majority of the Mail Creek population overwintered as instar III (Fig. 2). Recruitment of early instar individuals was nearly continuous in both populations.

**DISCUSSION**

Several studies report a wide range of life histories and emergence patterns for *C. analis* (as *pettiti*). MacKay (1986) and Morin and Harper (1986) report a univoltine life cycle in Minnesota and Montreal, whereas Sanchez and Hendricks (1997) document a bivoltine and partial bivoltine life cycle for this species in a southwestern Virginia stream. In contrast, Kondratieff et al. (1997) report continuous generations in a nonseasonal Hawaiian stream. Univoltine populations emerged from June through August in Minnesota (MacKay 1986), and May through August in Montreal (Morin and Harper 1986). Floyd and Schuster (1990) report the presence of *C. analis* adults from April through August in Kentucky, and Herrmann et al. (1986) report emergence from late April through early October in Colorado. Collection records from CSUC of *C. analis* from streams along the Front Range of Colorado indicate emergence from May through August.

The variety of life cycles and emergence patterns of *C. analis* agrees with earlier descriptions of the adaptability of this species to tolerate a wide variety of environmental conditions. The plasticity of *C. analis* has apparently allowed this species to become well adapted to the Front Range urban streams of Colorado, even though these streams have been subjected to over 175 years of disturbance (Wohl 2001). *Cheumatopsyche analis* often dominates caddisfly communities in small streams of this region (Zuellig 2001). Along with the *Hydropsyche bronta* group and *H. occidentalis* and several species of *Simulium*, especially *S. vittatum* complex, *C. analis* is often the dominant filter-feeding taxa present across the plains portion of the transition zone (Zuellig 2001, CSUC records). Since *C. analis* is among the few taxa occupying the filter-feeding trophic niche in small Front Range streams, it probably plays an important role in the energy flow of these systems. Unfortunately, no historical caddisfly records are available for small Front Range streams of Colorado prior to the initiation of irrigated agriculture (ca. 1860). It would be interesting to know if *C. analis* was historically the dominant caddisfly species in the eastern portion of the transition between mountains and plains or if it is dominant today because of the series of widespread stream modifications that have occurred across this region. For example, *C. analis* occurs, but

<table>
<thead>
<tr>
<th>Instar</th>
<th>Number of measurements</th>
<th>Mean head width (mm)</th>
<th>Range of head width (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SPRING CREEK</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>45</td>
<td>0.21 (0.01)</td>
<td>0.17–0.21</td>
</tr>
<tr>
<td>II</td>
<td>141</td>
<td>0.26 (0.01)</td>
<td>0.26–0.30</td>
</tr>
<tr>
<td>III</td>
<td>854</td>
<td>0.41 (0.02)</td>
<td>0.34–0.47</td>
</tr>
<tr>
<td>IV</td>
<td>1442</td>
<td>0.65 (0.04)</td>
<td>0.51–0.77</td>
</tr>
<tr>
<td>V</td>
<td>1636</td>
<td>1.00 (0.06)</td>
<td>0.81–1.40</td>
</tr>
<tr>
<td><strong>MAIL CREEK</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>61</td>
<td>0.21 (0.01)</td>
<td>0.17–0.21</td>
</tr>
<tr>
<td>II</td>
<td>247</td>
<td>0.26 (0.01)</td>
<td>0.26–0.30</td>
</tr>
<tr>
<td>III</td>
<td>1388</td>
<td>0.41 (0.02)</td>
<td>0.34–0.47</td>
</tr>
<tr>
<td>IV</td>
<td>1578</td>
<td>0.64 (0.03)</td>
<td>0.51–0.77</td>
</tr>
<tr>
<td>V</td>
<td>1260</td>
<td>0.98 (0.05)</td>
<td>0.81–1.37</td>
</tr>
</tbody>
</table>
is not common, in Chief Creek, which is a relatively undisturbed small stream in eastern Colorado, Yuma County (BCK personal observation).

The life cycle of *C. analis* from these 2 urban streams appears to be partially bivoltine with an extended period of emergence from an early generation in May and June followed by a partial generation in August that provides an almost continuous source of recruitment. Life cycle and emergence length and timing were variable when compared with other populations reported from different parts of the U.S. and Canada. The populations from these 2 urban streams most closely match the populations of *C. analis* described by Sanchez and Hendricks (1997) from southwestern Virginia. Apparently, the adaptability of *C. analis* has allowed this species to proliferate in these modified urban streams as well as in many different types of streams across its broad geographic distribution.

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**LITERATURE CITED**


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