2004/0112 FORT
MTF 22117

Western North American Naturalist 64(4), © 2004, pp. 497–502

LIFE CYCLE OF THE NET-SPINNING CADDISFLY, *CHEUMATOPSYCHE ANALIS* (BANKS) (TRICHOPTERA: HYDROPSYCHIDAE), IN TWO SMALL FRONT RANGE URBAN STREAMS, FORT COLLINS, COLORADO

Robert E. Zuellig[1], Boris C. Kondratieff[2], and Richard A. Thorp[2]

ABSTRACT.—The life cycle of *Cheumatopsyche analis* (Banks) is described from 2 urban streams located in north central Colorado. Larvae were collected every 15 days during spring, summer, and fall and every 30 days in winter from August 1999 through August 2000. A total of 8652 larvae were collected, and head capsules were measured to the nearest 0.01 mm. The life cycle of *C. analis* at both sites appears to be partially bivoltine with a long, almost continuous period of recruitment after peak emergence in June. Some offspring from the early generation that emerges in May probably emerge as adults in September, while the remainder of the population overwinter as instars III through V. Life cycle patterns for *C. analis* in these 2 urban streams were most similar to other populations of *Cheumatopsyche* from Virginia.

Key words: life cycle, Cheumatopsyche analis, *Hydropsychidae, urban stream.*

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. Dennehy 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 (Dennehy et al. 1993). Annual precipitation is <38 cm. Several authors have documented changes that

[1]Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO 80523.
[2]Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523

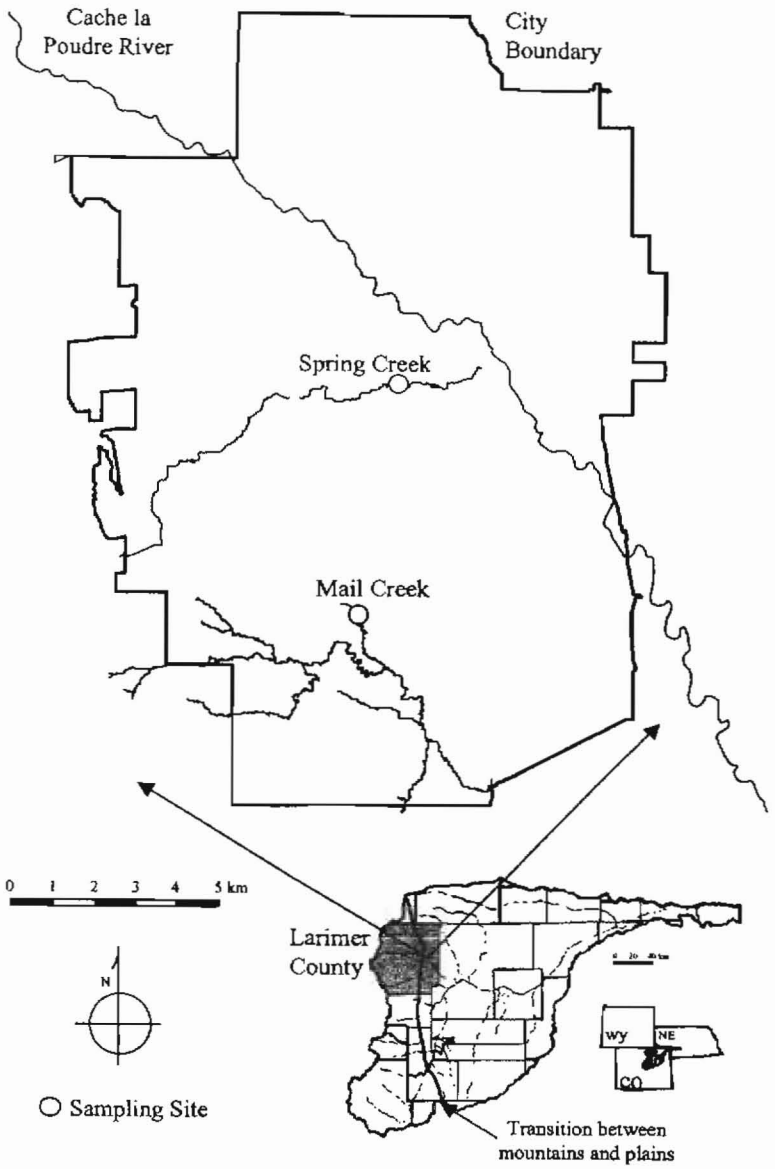

Fig. 1. Spring Creek and Mail Creek site locations in relation to the Cache la Poudre River, Larimer County, CO, and to the South Platte River basin.

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 aud ripariau 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 rubhed clean of any invertebrates for a period of 1 minute by a collector moving in an upstream direction. Samples were collected from August 1999 throngh 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 nsing a dissecting microscope eqnipped 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 matnre 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 literatnre. 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 cnrrently 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 capsnle width across instars at hoth sites (Table 1). Variability in head capsule width at both sites increased as larvae increased in size. Mean head capsule width of instars I throngh 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 nnmbers of adults were observed along stream margins during May and June, which we estimate as peak emergence for the early generation. Some

TABLE 1. *Cheumatopsyche analis* (Banks) head capsule measurement summary for Spring Creek and Mail Creek, City of Fort Collins, Larimer County, CO. (*s*) = standard deviation of mean head capsule width in mm.

Instar	Number of measurements	Mean head width (mm) (*s*)	Range of head width (mm)
SPRING CREEK			
I	45	0.21 (0.01)	0.17–0.21
II	141	0.26 (0.01)	0.26–0.30
III	854	0.41 (0.02)	0.34–0.47
IV	1412	0.65 (0.04)	0.51–0.77
V	1636	1.00 (0.06)	0.81–1.40
MAIL CREEK			
I	61	0.21 (0.01)	0.17–0.21
II	247	0.26 (0.01)	0.26–0.30
III	1388	0.41 (0.02)	0.34–0.47
IV	1578	0.64 (0.03)	0.51–0.77
V	1260	0.98 (0.05)	0.81–1.37

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

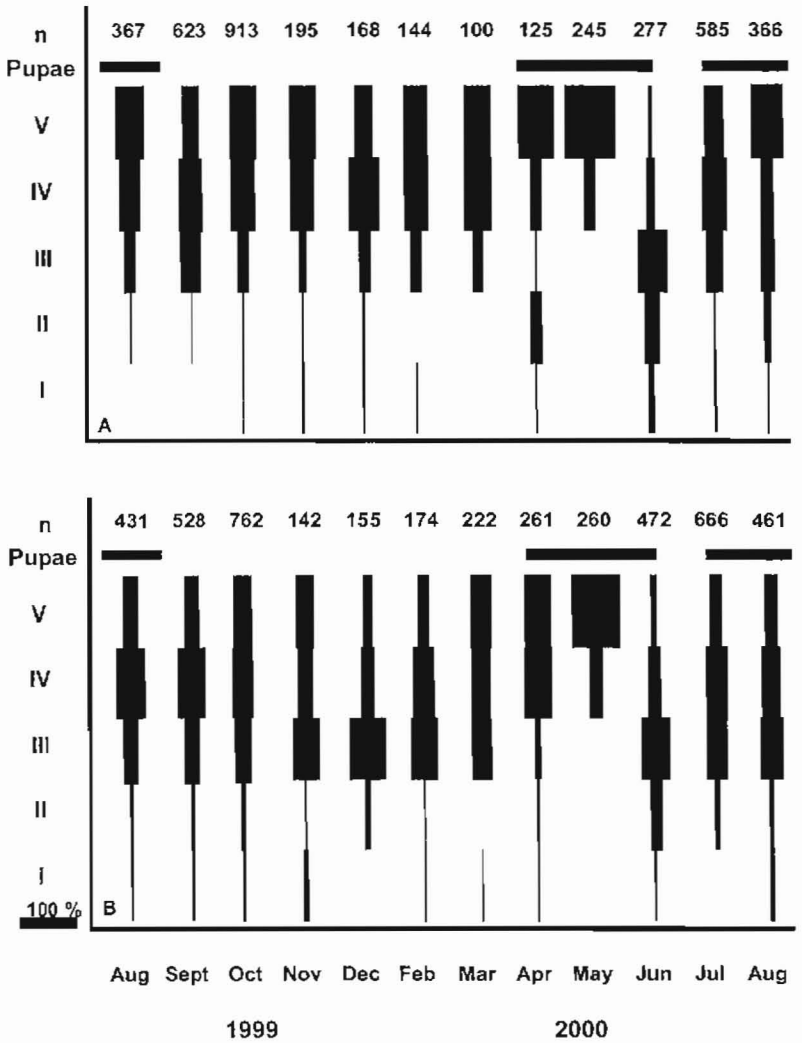

Fig. 2. Life cycle of *Cheumatopsyche analis* (Banks) collected from August 1999 to August 2000 from 2 urban streams, Spring Creek (A) and Mail Creek (B), Fort Collins, CO. Width of bar = 100% of the individuals collected during the corresponding month.

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.

ACKNOWLEDGMENTS

We thank David E. Ruiter, who graciously verified pupae and adult identifications and

reviewed an earlier version of this manuscript. Additionally, we thank Joe Nicholson and Tad Stout for helping process samples.

LITERATURE CITED

BENKE, A.C., AND J.B. WALLACE. 1980. Trophic basis of production among net-spinning caddisflies in a southern Appalachian stream. Ecology 61:108–118.

BOWLES, D.E., AND R.T. ALLEN. 1991. Secondary production of net-spinning caddisflies (Trichoptera: Curvipalpia) in an Ozark stream. Journal of Freshwater Ecology 6:93–100.

DENNEHY, K.F., D.W. LITKE, C.M. TATE, AND J.S. HEINY. 1993. South Platte River basin—Colorado, Nebraska, and Wyoming. Water Resources Bulletin 29:647–683.

ESCHNER, T.R., R.F. HADLEY, AND K.D. CROWLEY. 1983. Hydrologic and morphologic changes of the Platte River basin in Colorado, Wyoming, and Nebraska: a historical perspective. U.S. Geological Survey Professional Paper 1277-A.

FLINT, O.S., JR., AND R.A. ENGLAND. 2003. A reassignment and new state records of Trichoptera occurring in Hawai'i with discussion on origins and potential ecological impacts. Records of the Hawaii Biological Survey for 2001–2002. Bishop Museum Occasional Papers 73:31–40.

FLOYD, M.A., AND C.A. SCHUSTER. 1990. The caddisflies (Insecta: Trichoptera) of the Buck Creek system, Pulaski County, Kentucky. Transactions of the Kentucky Academy of Sciences 51:127–134.

GORDON, A.E. 1974. A synopsis and phylogenetic outline of the Nearctic members of *Cheumatopsyche*. Proceedings of the Academy of Natural Sciences of Philadelphia 126:117–160.

GORDON, A.E., AND J.B. WALLACE. 1975. Distribution of the family Hydropsychidae (Trichoptera) in the Savannah River basin of North Carolina, South Carolina and Georgia. Hydrobiologia 46:405–423.

HERRMANN, S.J., D.E. RUTER, AND J.D. UNZICKER. 1986. Distribution and records of Colorado Trichoptera. Southwestern Naturalist 31:421–457.

KONDRATIEFF, B.C., R.J. BISHOP, AND A.M. BRASHER. 1997. The life cycle of an introduced caddisfly, *Cheumatopsyche pettiti* (Banks) (Trichoptera: Hydropsychidae), in Waikolu Stream, Molokai, Hawaii. Hydrobiologia 350:81–85.

MACKAY, R.J. 1986. Life cycles of *Hydropsyche riola*, *H. slossonae* and *Cheumatopsyche pettiti* (Trichoptera: Hydropsyche) in a spring-fed stream in Minnesota. American Midland Naturalist 115:19–24.

MORIN, A., AND P. HARPER. 1986. Phenology and microdistribution of adults and larvae of filter-feeding Trichoptera in lower Laurentian Lake outlet (Quebec). Archives of Hydrobiologia 108:167–183.

PARKER, C.R., AND J.R. VOSHELL. 1983. Production of filter-feeding Trichoptera in an impounded and a free-flowing river. Canadian Journal of Zoology 61:70–87.

PAUL, M.J., AND J.L. MEYER. 2001. Streams in the urban landscape. Annual Review of Ecological Systems 32: 333–365.

SANCHEZ, R.M., AND A.C. HENDRICKS. 1997. Life history and secondary production of *Cheumatopsyche* spp. in a small Appalachian stream with two different land uses on its watershed. Hydrobiologica 354: 127–139.

SMOCK, L.A., AND C.E. ROEDING. 1986. The trophic basis of production of the macroinvertebrate community of a southeastern USA blackwater stream. Holarctic Ecology 9:165–174.

WALLACE, J.B. 1975. Food partitioning in net-spinning Trichoptera larvae: *Hydropsyche venularis*, *Cheumatopsyche etrona*, and *Macronema zebratum* (Hydropsychidae). Annals of the American Entomological Society 68:463–472.

WALLACE, J.B., AND R.W. MERRITT. 1980. Filter-feeding ecology of aquatic insects. Annual Review of Entomology 25:103–132.

WIGGINS, G.B. 1996. Larvae of the North American caddisfly genera (Trichoptera). 2nd edition. University of Toronto Press, Toronto, Canada.

WOHL, E.E. 2001. Virtual rivers: lessons from the mountain rivers of the Colorado Front Range. Yale University Press, New Haven, CT, and London.

ZUELLIG, R.E. 2001. Macroinvertebrate and fish communities along the Front Range of Colorado and their relationship to habitat in the urban environment, Master's thesis, Colorado State University, Fort Collins.

Received 25 November 2003
Accepted 31 March 2004