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THE LIFE HISTORY OF *OSTROCERCA DIMICKI* (FRISON) IN A SHORT-FLOW, SUMMER-DRY OREGON STREAM

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ABSTRACT

The voltinism and life history of *Ostrocerca dimicki* (Frison) were determined from monthly benthic collections of larvae, and adults from an emergence trap, from a short-flow, intermittent stream. Collections were from four water years, 1996-97, 1997-98, 1998-99, and 2002-03, selected from 17 years of samples. Determination of emergence timing was supplemented by collections of adults in 2008, from 10 emergence traps set to include a range of habitat types on the receiving seasonal stream. Growth was assessed by increase of head- capsule width of 667 larvae. A total of 202 males and 261 females were taken in the 4-year and 2008 emergence trap samples. Emergence in late February- April, first appearance of early- instar larvae the following December or January about a month after typical resumption of water flow, and rapid growth in 3-4 months, indicated a straightforward univoltine, fast cycle, with a probable over-summer egg diapause. Population levels fluctuated substantially over the 17-year period, depending on rainfall and duration of flow. Drought periods reduced the population, leading to low or no emergence and subsequent slow recovery, presumably from long-term diapausing eggs.

Keywords: Plecoptera, *Ostrocerca*, Nemouridae, Life History, Oregon

INTRODUCTION

Detailed life histories are known for less than 10% of the North American stonefly species, and for 19 species, representing about 26% of the Nemouridae fauna (Stewart & Stark 2002; Stewart & Anderson 2009). Nemourids are often a dominant element of the stonefly assemblage of small headwater streams, both permanent and temporary, and play an important role in their resource partitioning and energy dynamics. The reported life histories for Nearctic species are all univoltine, with greatly variable emergence phenologies, egg development, and larval growth patterns (Stewart & Anderson 2009).

Life histories of four of the six *Ostrocerca* species have been reported; three eastern, *Ostrocerca albidipennis* (Walker) (Mackay 1969), *Ostrocerca prolongata* (Claassen) (Harper 1990), *Ostrocerca truncata* (Claassen) (Harper et al. 1991), and the western *Ostrocerca foersteri* (Ricker) (Dieterich & Anderson 1995). All were fast, univoltine life cycles, with emergence in spring, an over-summer egg diapause, first recruitment in the fall, and fast larval growth through winter and early spring. In the case of those in intermittent streams (*O. prolongata* and *O. foersteri*), larvae were found only during surface water flow.

Stewart & Anderson (2008) described the late-instar larva of *Ostrocerca dimicki* (Frison), field correlated with adults from a very small temporary stream named Outgate Beck on author Anderson's property. The stream is near 60th Street, less than 1 km north of Corvallis, Benton County, Oregon. In over 15 years of emergence-trap collections, no other congeners were present and only small numbers of one other stonefly species, *Podmosta obscura* (Frison) were taken (about 10% of the numbers of *O. dimicki*).

This is the first report of the life history of *O. dimicki*, as determined from monthly benthic and twice monthly emergence- trap samples. The life histories and generic character development of two other stoneflies, *Sweltsa adamantea* Surdick (Stewart & Anderson 2009a) and *Malenka bifurcata* (Claassen) (Stewart & Anderson 2009b) were reported from the receiving stream of Outgate Beck, named Oak Burn, on the same property. *O. dimicki* is also present in Oak Burn along with its congener *O. foersteri* whose larva has not been described. The report on the life history of *O. foersteri* (Dieterich & Anderson 1995) was from forested streams located in or adjacent to the Oak Creek catchment in McDonald Forest, 8 km northwest of Corvallis where *O. dimicki* was absent.

Fig. 1. Outgate Beck stream channel obscured by grass, looking upstream from the emergence trap; author Anderson straddling the stream.

STUDY STREAM AND METHODS

Stewart & Anderson (2008) gave a brief description of the study stream, Outgate Beck, a short-flow meadow tributary to Oak Burn, with about one quarter of the discharge of Oak Burn. Outgate Beck starts as a roadside ditch between 150-175m above sea level, and then goes subsurface. There is no defined channel where it bubbles out on a hillside but downstream in the 40m study section, it flows in a channel about 30-60cm wide and is largely overcanopied with grass in an open meadow (Figs. 1, 2). A pool and clumps of willow and hawthorn are located further downstream near the emergence trap (Figs. 3, 4). After the ground is saturated by autumn rains, Outgate Beck is very flashy and responds to storm events with overland flow; however, it is usually back in its channel within a few hours after a downpour. Flow is over shallow soil, so when the first hot days occur, usually in May, complete drying is rapid. The typical flow interval is from mid-November to mid-May, and the mean duration of flow over 17 years was 179 days, or about six months.

Monthly benthic samples of larvae were collected from Outgate Beck during the flow interval from 1993 to 2008, except for the water years 1999-2000 and 2000-2001. A small soil scoop was used to disturb the substrates (mostly grass debris) in front of the collecting net. The net and substrate samples were washed over a 0.5 mm mesh sieve. The sieve was submerged in a pan of water overnight and live larvae were picked from the debris with forceps the following day. Small larvae that crawled through the

Fig. 2. Closeup of stream with 30cm ruler.

Fig. 3. Outgate Beck, looking downstream to the emergence trap; about half the length of the study section.
Fig. 4. Emergence trap closeup.

sieve were readily collected because they were separated from the debris. Larvae were preserved in 70-80% ethanol.

Adults were collected twice monthly in the emergence trap shown in Fig. 4. Design, measurements and placement of similar traps were described by Stewart & Anderson (2009a, b).

Larvae collected from Outgate Beck during the 1996-97, 1997-98, 1998-99, and 2002-03 water years (Table 2) were used for growth and voltinism analysis because of larger numbers recovered in those years. Growth was assessed by increase of head -capsule width (hcw), measured with a calibrated ocular micrometer on a Wild M-5 stereomicroscope. Emergence was determined from adults taken from the emergence trap over the same selected water years as were the larvae. These data were supplemented with numbers of adults from a larger emergence study in 2008 from 10 traps on Oak Burn set to include the range of habitat types in upstream and downstream reaches.

As in our study of *Malenka bifurcata* (Stewart & Anderson 2009b), eggs were not studied, since the emergence-trapped females contained immature soft eggs without developed and sculptured chorions, and ovipositing females were not collected in the field to attempt incubation. Newly emerged female nemourids typically fly or crawl into riparian vegetation to feed and mate before ovipositing (Hynes 1942; Harper 1973).

RESULTS AND DISCUSSION

A total of 51 males and 69 females was taken in the Outgate Beck emergence trap during the selected four water years (Fig. 5); and an additional 151 males and 192 females from the 10 traps from the 2008 Oak Burn study. A total of 1850 nemourid larvae was collected in benthic samples from Outgate Beck from 1993 to 2008 (an estimated 90% were *O. dimicki* (Table 1). Head -capsule widths of 667 larvae from the selected water years were measured for growth analysis (Table 2). Head -capsule widths of the larvae

Table1. Outgate Beck: Flow Duration and Number of Nemourids Collected 1992-2009.
* Drought years

Dates	Wetted Interval	Duration (Days)	Rainfall (cm)	Nemourids Larvae	Nemourids Adults
92-93	Nov. 21-June 15	206	123.2	40	9
93-94*	Dec. 8-May 10	153	79.5	171	5
94-95	Nov. 5-May 25	201	147.1	239	20
95-96	Nov. 9-June 10	214	184.9	75	3
96-97	Nov. 17-May 15	179	185.9	229	19
97-98	Oct. 9-June 15	249	143.3	341	20
98-99	Nov. 20-May 31	192	176.0	445	46
99-00	Nov. 23-May 31	190	126.5	-	40
00-01*	Dec. 16-May 12	147	70.6	-	2
01-02	Nov. 22-May 14	173	130.8	35	25
02-03	Dec. 13-May 31	169	121.9	34	12
03-04	Nov. 29-May 24	177	128.5	32	10
04-05*	Dec. 8-March 11	93	90.0	52	0
05-06	Nov. 25-May 15	171	145.3	5	2
06-07	Nov. 7-May 14	183	129.0	110	9
07-08	Nov. 18-May 16	180	123.7	42	2
08-09	Dec. 21-May 29	159	94.2	-	10

ranged from 0.33 to 1.32mm, and average monthly hcw ranged from 0.37 to 1.17mm (Table 2; Fig. 5).

Adult emergence from Outgate Beck occurred from February to the end of April (Fig. 5). This timing, with addition of small numbers of emergers in May-early June, was corroborated by the 151 males and 175 females taken from the 10 larger traps in the 2008 Oak Burn sampling (132♂, 94♀ March 16-April 15; 16♂, 44♀ April 16-30; 3♂, 37♀ May 1-June 6), that indicated an emergence protandry.

The combination of: (1) presence of only pre-emergent sized larvae in March; (2) emergence from late February to the end of April; (3) absence of all sizes of larvae from the end of March until the smallest instars appear the following December or January, about a month after typical resumption of water flow; and (4) rapid growth of larvae for only 3 or 4 months (Fig. 5), indicates a straightforward univoltine, fast life cycle for *O. dimicki.* Growth of larvae showed the same pattern in all years (Fig. 5), except one anomalous low value data point and outlying graph plot of January 27, 1999 (Table 2, Fig.5). This average hcw for that date was from a subsample of 76 larvae measured, that represented the largest collection of larvae during the study (n= 265). We believe this low value is an artifact, but the delayed growth could also be weather related. Although egg development was not determined, the absence of early instars from spring emergence until the following December-January suggests an egg diapause until resumption of flow, typically in November. Hatch and development of larvae through the first few instars presumably occurred over the short period from then until we detected the smallest larvae in December or January.

The univoltine fast cycle of *O. dimicki*, therefore, is similar to the other *Ostrocerca* species that have been reported; however, larval development may be shorter and historically adapted to the short term flow of Outgate Beck and similar small streams. The species appears to be almost restricted to summer-dry streams, especially those with no or little forest canopy. Population levels of *O. dimicki* in Outgate Beck fluctuated substantially depending on rainfall

Table 2. Numbers and Head Capsule Measurements of *O. dimicki* Larvae from Outgate Beck 1996-2003.

Date	n	Head Capsule Width millimeters		
		Maximum	Minimum	Average
Dec. 3, 1996	3	0.39	0.36	0.37
Dec. 31, 1996	65	0.87	0.39	0.64
Feb. 1, 1997	48	1.26	0.87	0.98
Feb. 28, 1997	41	1.29	0.84	1.08
Mar. 28, 1997	11	1.29	0.96	1.16
Jan. 2, 1998	109	0.84	0.39	0.59
Jan. 29, 1998	124	1.20	0.42	0.86
Feb 27, 1998	69	1.29	0.87	1.09
Mar. 31, 1998	6	1.20	1.05	1.13
Dec. 28, 1998	25	0.63	0.42	0.50
Jan. 27, 1999	76	0.54	0.33	0.46
Feb. 27, 1999	58	1.32	0.78	1.15
Mar. 30, 1999	6	1.32	1.02	1.17
Jan. 28, 2003	13	0.87	0.63	0.77
Feb. 27, 2003	13	1.23	0.96	1.12

	Feb	Mar	Apr	May	Total
♀	4	28	37	0	69
♂	2	31	18	0	51

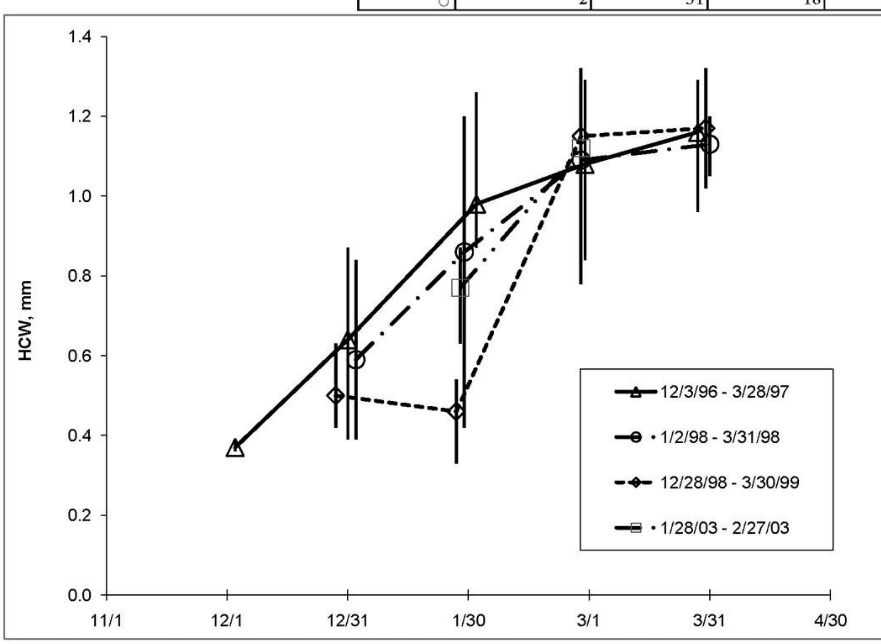

Fig. 5. Emergence and growth of *O. dimicki*, 1996-1999, and 2003 in Outgate Beck. Plots are average hcw measurements for n larvae in Table 2, and vertical lines through plots are range of hcw. Horizontal bars at top show monthly emergence numbers of males and females.

and duration of flow. Generally, population reduction, particularly emergence as an indicator of a successful cohort, occurred during and after the low rainfall years of 1993-94, 2000-01, and 2004-05 (Table 1). Specifically as an example, in the most severe El Nino year of 2004-05, when there was a drought, rainfall in the Oak Burn-Outgate Beck catchment was 65% of average, the flow interval was only 93 days, or about half of average, and Outgate Beck was dry by March 11. A wet spring initiated reflow after three weeks (on March 24) and this continued until June 1 (= 68 days of reflow). During that water year, only 52 larvae and no adults were collected from Outgate Beck (Table 1), which suggests that the 93- day initial flow was insufficient for completion of larval development resulting in no emergence, and that the 68 days of reflow after drying had no beneficial effect. Recovery after such a period is probably from hatch of some eggs that have diapaused for longer than one dry summer interval. Such differential breaking of diapause and hatch of a given cohort of eggs has been demonstrated for other stoneflies in both intermittent and permanent streams (Snellen & Stewart 1979; Sandberg & Stewart 2004), depending variously on temperature and/or surface flow conditions. The anomaly of low emergence in the 1995-96 high water year (Table 1) when the number of larvae in the benthos collections that year was 75, might be explained by a spate in mid-April that could have flushed out some of the population.

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REFERENCES

Dieterich, M. & N.H. Anderson. 1995. Life cycles and food habits of mayflies and stoneflies from temporary streams in western Oregon. Freshwater Biology, 34:47-60.

Harper, P.P. 1973. Life histories of Nemouridae and Leuctridae in southern Ontario (Plecoptera). Hydrobiologia, 41:309-356.

Harper, P.P. 1990. Life cycles of *Leuctra duplicata* and *Ostrocerca prolongata* in an intermittent streamlet in Quebec (Plecoptera: Leuctridae and Nemouridae). Great Lakes Entomologist, 23:211-216.

Harper, P.P., M. Lauzon, & F. Harper. 1991. Life cycles of sundry stoneflies (Plecoptera) from Quebec. Rev. d' Ent. Quebec, 36:28-42.

Hynes, H.B.N. 1942. A study of the feeding of adult stoneflies (Plecoptera). Proceedings of the Royal Entomological Society of London (A), 17:81-82.

Mackay, R.J. 1969. Aquatic insect communities of a small stream on Mont. St. Hilaire, Quebec. Journal of the Fisheries Research Board of Canada, 26:1157-1183.

Sandberg, J.B. & K.W. Stewart. 2004. Capacity for extended egg diapause in six *Isogenoides* Klapalek species (Plecoptera: Perlodidae). Transactions of the American Entomological Society, 130:411-423.

Snellen, R.K. & K.W. Stewart. 1979. The life cycle and drumming behavior of *Zealeuctra claasseni* (Frison) and *Zealeuctra hitei* Ricker & Ross (Plecoptera: Leuctridae) in Texas, USA. Aquatic Insects, 1:65-89.

Stewart, K.W. & N.H. Anderson. 2008. The nymphs of three Nemouridae species (Plecoptera) from Oregon temporary headwater streams. Transactions of the American Entomological Society, 134:173-183.

Stewart, K.W. & N.H. Anderson. 2009a. The life history and nymphal generic character development of *Sweltsa adamantea* Surdick (Plecoptera; Chloroperlidae) in an Oregon summer-dry headwater stream. Transactions of the American Entomological Society, 135:161-173.

Stewart, K.W. & N.H. Anderson. 2009b. The life history and larval generic character development of *Malenka bifurcata* (Claassen, 1923) (Plecoptera: Nemouridae) in an Oregon summer-dry stream. Aquatic Insects, 31 Supplement:391-399.

Stewart, K.W. & B.P. Stark. 2002. Nymphs of North American stonefly genera (Plecoptera), 2nd Ed. The Caddis Press, Columbus, Ohio. 510pp.

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