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Ontogeny of Larval and Juvenile Black Redhorse (*Moxostoma duquesnei*)

Christopher M. Bunt[1], Thom Heiman[2], and Nicholas E. Mandrak[2]

Adult Black Redhorse (*Moxostoma duquesnei*) were seined from the Grand River, Ontario and artificially spawned in May 2007 and May 2008. Eggs hatched after 9–16 days at a mean temperature of 20°C, and after 11–25 days at a mean temperature of 17°C. Eggs did not develop fully at temperatures <11°C. Eggs and development of larvae between 9 and 24 mm TL, and juveniles up to 35 mm TL are described. Ontogeny of larval and juvenile Black Redhorse was compared to that of Greater Redhorse (*Moxostoma valenciennesi*), River Redhorse (*Moxostoma carinatum*), Golden Redhorse (*Moxostoma erythrurum*), Shorthead Redhorse (*Moxostoma macrolepidotum*), Copper Redhorse (*Moxostoma hubbsi*), and Spotted Sucker (*Minytrema melanops*). There was significant overlap between most meristic variables compared. However, the majority of Black Redhorse in this study (up to 18 mm TL) generally had higher myomere counts that were different from most other redhorse species. These data, in combination with knowledge of variation in congeneric distributions and differences in spawning windows, may allow identification of Black Redhorse as small as 9 mm TL.

THERE has been a revival of studies examining ontogenetic development of redhorse suckers (e.g., Bunt and Cooke, 2004) since publication of comprehensive research on catostomid fishes by Buynak and Mohr (1977, 1978a, 1978b, 1978c, 1979), Fuiman (1979), and Fuiman and Whitman (1979). Kay et al. (1994) reviewed the early life history of catostomids in the Ohio River drainage basin and briefly described the early life history of Black Redhorse (*Moxostoma duquesnei*). However, there is no information on development of this species outside of the Ohio River drainage basin (Kay et al., 1994), and no information exists for any population in Canada, where this species is designated as threatened (COSEWIC, 2005). Black Redhorse are also provincially listed as threatened in Ontario (OMNR, 2007). Data for this species in early life-history stage taxonomic keys are based on limited information from one study in one distinct geographic area, despite the species being relatively widespread in the Mississippi and Great Lakes basins. In Canada, disjunct and fragmented Black Redhorse populations have been documented from Ontario in the Thames River watershed (Lake St. Clair drainage), Ausauble River, Bayfield River, and Maitland River watersheds in the Lake Huron drainage, Catfish Creek, Spencer Creek in the Lake Ontario drainage basin, and the Grand River watershed in the Lake Erie drainage basin (COSEWIC, 2005).

The Grand River, a large tributary of Lake Erie in Ontario, supports populations of black redhorse along with at least seven other catostomid species. Descriptions of early life history are available for all other suckers in this drainage including Greater Redhorse (*M. valenciennesi*, Bunt and Cooke, 2004), White Sucker (*Catostomus commersoni*, Buynak and Mohr, 1978c; Fuiman and Whitman, 1979), Northern Hog Sucker (*Hypentelium nigricans*, Buynak and Mohr, 1978a; Fuiman, 1979), Longnose Sucker (*Catostomus catostomus*, Fuiman, 1979), Shorthead Redhorse (*M. macrolepidotum*, Buynak and Mohr, 1979; Fuiman, 1979), Golden Redhorse (*M. erythrurum*, Fuiman and Whitman, 1979; Kay et al., 1994), and River Redhorse (*M. carinatum*, Kay et al., 1994). The purpose of this study was to describe the early stages of development of a northern population of Black Redhorse from the Grand River and to compare results with the only other similar study of a more southerly population in Tennessee, USA that predates the current study by 30 years. Other objectives were to identify diagnostic characters to distinguish larvae of this species from other syntopic catostomids, and to provide early life-history information for this species within the northern portion of its North American distribution.

MATERIALS AND METHODS

Gravid Black Redhorse were seined from known spawning locations in the Grand River near Kitchener, Ontario, approximately 500 m downstream from the Mannheim Weir (43°25′46″N, 80°25′58″W) and then artificially spawned on 23 May 2007 and 24 May 2008 (river temperature approximately 15°C). At this site, Black Redhorse spawn on the same riffles as Greater Redhorse, but Black Redhorse spawning usually peaks after the majority of Greater Redhorse spawning is complete. Details related to habitat and spawning of Greater Redhorse in these areas in the Grand River are published in Cooke and Bunt (1999) and Bunt and Cooke (2001).

Eggs fertilized in 2007 were reared in ambient Grand River water in a commercially available mesh fry enclosure (approximate dimensions: 10 cm × 10 cm × 20 cm) in four replicate plastic flow-through tubs. In 2008, eggs and larvae were reared under an artificial wide-spectrum photoperiod set to match natural conditions in 15 aerated aquaria (9.5 L) with flow-through Grand River water and gravel substrate, similar to that found at spawning riffles, at controlled temperatures between 10°C and 20°C. Ten aquaria were thermostatically regulated to two temperatures (10°C and 20°C), and five aquaria were set to ambient (run-of-the-river) temperatures. Larvae were fed live *Nanochloropsis* gut-loaded *Artemia* several times daily after swim-up until the end of August 2008. Larger larvae (>15 mm TL, all fish lengths from here on are reported in mm TL) and juvenile fish (>22 mm) were also fed a combination of freeze-dried chironomid larvae, freeze-dried tubifex worms, and fry powder. Observations of larval feeding behavior, swimming behavior, yolk-sac absorption, and pigmentation were recorded regularly and descriptions are included where appropriate. Some fish were retained and regularly fed a

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diverse diet of frozen chironomid larvae, commercially available dried shrimp and algae pellets in a run-of-the-river (temperature) 450 L aquarium for more than three years to observe thermally induced pigmentation changes and overwintering behavior.

Every two or three days, three or four larval fish were removed randomly from replicate sets of aquaria in which larvae emerged from the hatchery substrate. These fish were examined with a stereo microscope and high-resolution digital video camera. Larval fish samples were preserved in 4% buffered formalin following total length measurements (in mm), and descriptions of general morphology and pigmentation. Morphometric and meristic characters were examined from the preserved series from 2007 and 2008 within one year of sample collection. Morphometric data are reported as percent total length (TL) to minimize problems with shrinkage due to preservation (Xiong et al., 2007).

Morphometric and meristic data were summarized by larval phase following Fuiman (1979). All morphometric features except post-anal length were defined in Snyder (1976). The definition of post-anal length was taken from Hogue and Buchanan (1977). All measurements were made to the nearest 0.1 mm with a digital caliper on scaled and magnified video images captured using a PC. Post-anal myomeres were those posterior to, but not intersected (Siefert, 1969) by, an imaginary vertical line through the body at the posterior margin of the anus (Kay et al., 1994). Images of preserved larvae were hand drawn, and some details were added following microscopic examination (Buynak and Mohr, 1978b). Each drawing (Figs. 1–4) was scaled to the shortest larva (13.7 mm) and was drawn at 16 times actual length. Drawings were made freehand after measuring various landmarks (size of eye, distance from snout to fin base) on each specimen. Measurements were made using an ocular micrometer at 12× power. Stippling represents structures or pigmentation: no shading was used to avoid misinterpretation of pigmentation. Density of pigmentation represents that which can be readily seen (such as under tissue in eyes), but no attempt was made to differentiate between internal and external pigmentation.

Student's t-test was used to statistically compare mean values of pre-anal, post-anal, and total myomere counts between protolarvae (8–14 mm), mesolarvae (14.1–18 mm), and metalarvae (18.1–24 mm) from the Grand River and the Ohio River drainage (Kay et al., 1994).

RESULTS

Eggs and hatching.—Fertilized and water-hardened eggs were yellow, 3–3.5 mm in mean diameter (n = 5), demersal, and nonadhesive. In 2007, eggs maintained at ambient river temperatures began hatching after nine days and protolarvae were collected for analysis regularly (every 2–3 days) for a period of approximately five weeks. Upon hatching, protolarvae measured 7–8 mm and wriggled actively on the bottom of the hatchery enclosure. Early protolarvae lacked significant distinguishing features and provided limited meristic data. Eyes and heart were clearly visible, the notochord was elongate, and the yolk sac was bulbous anteriorly. Five days post-hatch, eyes were more developed and the yolk sac became elongate. After ten days, yolk sacs were 80–85% absorbed and most larvae were free swimming. Fourteen days post-hatch, the dorsal finfold was present, and most larvae were free swimming in school formation.

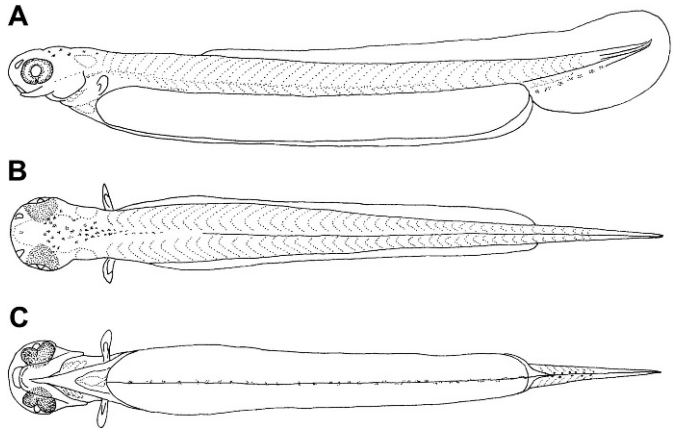

Fig. 1. Lateral (A), dorsal (B), and ventral (C) views of Black Redhorse (*Moxostoma duquesnei*) protolarvae (13.7 mm TL).

Under laboratory conditions in 2008, artificially spawned eggs hatched and fish swam up from the substrate after 9–16 days at 20°C and from 11–25 days at ambient (run-of-the-river) temperatures. Black Redhorse required 188 degree-days between fertilization and first emergence of hatched larvae from spawning substrate (Fig. 5). Some eggs hatched, but did not develop properly/fully, and no fish emerged from the substrate in any of the five aquaria thermally maintained at 10°C. By the time these replicates achieved 188 cumulative degree-days, all eggs and undeveloped larvae had succumbed to fungus. Upon hatching in run-of-the-river replicates as well as the set of aquaria maintained at 20°C, larvae remained generally quiescent on the bottom of the rearing tank and became free-swimming after about 9–11 days. The following descriptions of morphology, pigmentation, and meristics were based on laboratory specimens artificially spawned and reared in 2008:

PROTOLARVAE

Figure 1 (8–14 mm TL)

Morphology.—Protolarvae lacked caudal-fin rays (Fuiman, 1979), but incipient rays generally began forming by about 12 mm. The post-anal finfold and urostyle were upcurved, the head was deflected over the anterior end of the yolk sac, and eyes were not fully developed and pigmented (Fig. 1A). Two chambers of the heart were visible as were the branchial arches and notocord. The yolk-sac was bulbous anteriorly, and yolk finely granular. Otoliths and nares became apparent in individuals >11 mm, at which stage the head was no longer decurved. Morphometric information for protolarval Black Redhorse is provided in Table 1 and myomere data are summarized in Table 2. The pre-anal myomere count ranged from 29 to 35 (mean 32) in this study, whereas in Kay et al. (1994) counts ranged from 34 to 41 (mean 40; P = 0.005, Table 3). Protolarvae post-anal myomeres ranged from 6–11 (mean 8) and total myomeres ranged from 39–43 (mean 40). In comparison, Kay et al. (1994) protolarvae post-anal myomere counts ranged from 3 to 9 (mean 5, P = 0.006) and total myomere counts ranged from 41 to 45 (mean 43, P = 0.01, Table 3). Note that undeveloped, deformed, or inadvertently damaged specimens were not included in the analysis because we were not able to accurately count all sets of protolarval myomeres.

Table 1. Morphometric Data for Protolarval, Mesolarval, and Metalarval Black Redhorse. Mean and range are expressed as percent of TL. Abbreviations: PreAL = pre-anal length, PreDFL = predorsal fin length, HD = head depth, BDA = body depth at anus, ED = eye diameter, and HW = head width.

Larval stage	TL (mm)	*n*	TL (mm)	PreAL (%)	PreDFL (%)	HD (%)	BDA (%)	ED (%)	HW (%)
Proto	8–14	10	13.1 (11.1–14.2)	74.1 (54.0–82.4)	38.7 (30.9–48.6)	12.9 (9.6–15.3)	9.7 (6.8–15.1)	6.5 (4.9–8.1)	11.1 (9.3–13.7)
Meso	14.1–18	72	15.9 (13.5–17.9)	70.5 (50.0–83.2)	41.1 (32.1–48.4)	12.9 (10.8–15.7)	9.3 (5.7–13.6)	6.9 (5.1–8.8)	10.8 (7.1–13.5)
Meta	18.1–24	19	20.0 (18–23.7)	68.6 (64.1–72.9)	40.9 (37.6–47.9)	13.9 (12.4–16.7)	10.1 (7.5–12.5)	6.2 (5.6–7.2)	11.3 (10.1–13.5)

Pigmentation.—Retinal pigmentation was lacking in protolarvae and pigmentation was slight in and around the eyes of individuals <11 mm. Larvae >11 mm had well-developed lenses and retinal pigmentation, and the eyes were black. Sparse, expanded melanophores were sometimes present along the ventral midline of specimens >11 mm, and those >12 mm had stellate melanophores along the ventral midline, and sparse pigmentation along the dorsal midline and post-anal finfold. Melanophores were present along the horizontal myosepta of the myomeres forming a line of pigmentation from the pectoral fins to the posterior end of the yolk sac. The lower lobe of the caudal fin had a row of stellate melanophores. Stellate melanophores were most dense behind the eyes and occipital region before narrowing to a row running predorsally.

MESOLARVAE

Figure 2 (14.1–18 mm TL)

Morphology.—Mesolarval morphometric information is summarized in Table 1. These specimens each had at least one distinct caudal-fin ray (Fuiman, 1979). Specimens approximately 14.5 mm had pectoral-fin buds with rays, with a range of 17–25 total caudal-fin rays (mean 20). Incipient rays were visible in the dorsal finfold. Yolk was finely granular but diminished somewhat, and the yolk sac was no longer bulbous. Eyes were fully developed, the mouth was slightly subterminal at eye level, and the opercula and the gas bladder were apparent. The yolk sac was completely absorbed by about 15 mm. The digestive tract was complete and began to coil toward the anterior by about 15.5 mm. The anal fin began forming in the anal finfold and incipient rays were visible in specimens >15 mm. Pelvic-fin buds began to develop by about 14.5 mm, the mouth became sub-terminal by about 16.5 mm, and larvae assumed a benthic feeding habit. Most specimens (73%, n = 49) had between 34 and 38 pre-anal myomeres (range 26–41, n = 67). Post-anal and total myomere counts were 6–11 for 86% of specimens (range 6–18) and 40–47 for 92% of specimens (range 38–49), respectively. These myomere results are summarized in Table 2. Comparison of mesolarval pre-anal and total myomere counts with Kay et al. (1994) indicated no significant difference (P = 0.47, P = 0.14); however, mesolarval post-anal myomere counts were significantly different (P = 0.002, Table 3).

Pigmentation.—Stellate melanophores were present on the nape, on the horizontal myoseptum of the myomeres, dorsal midline, and ventral midline from head to anus.

Table 2. Frequency Distribution of Myomere Counts. Pre-anal (Top), post-anal (Middle), and total (Bottom) myomere counts for Black Redhorse protolarvae, mesolarvae, and metalarvae represented as a function of total length.

		Pre-anal myomeres															
Larval stage	TL range	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Proto	8.0–14.0	–	–	–	1	–	1	–	–	1	1	–	–	–	–	–	–
Meso	14.1–18.0	2	1		3	1	3	2	4	13	13	6	8	9	1	–	1
Meta	18.1–24.0	–	–	–	–	–	–	–	–	2	1	6	2	–	3	–	–

		Post-anal myomeres												
Larval stage	TL range	6	7	8	9	10	11	12	13	14	15	16	17	18
Proto	8.0–14.0	2	–	1	–	–	1	–	–	–	–	–	–	–
Meso	14.1–18.0	8	16	15	8	7	6	2	2	3	2	–	–	1
Meta	18.1–24.0	–	5	7	2	2	1	–	–	–	–	–	–	–

		Total myomeres											
Larval stage	TL range	38	39	40	41	42	43	44	45	46	47	48	49
Proto	8.0–14.0	–	1	2	–	–	1	–	–	–	–	–	–
Meso	14.1–18.0	1	–	5	8	14	8	9	11	6	4	1	3
Meta	18.1–24.0	–	–	–	–	2	3	2	2	1	3	1	–

Table 3. Comparison of Typical Myomere Counts and Selected Morphometric Features. Summary of data for larval Black Redhorse, Greater Redhorse, River Redhorse, Golden Redhorse, Shorthead Redhorse, Spotted Sucker, and Copper Redhorse. Results of statistical comparisons (* indicates significance) between data for various developmental stages of Black Redhorse are shown.

	Myomeres			% Body length (TL)						
Species	Pre-anal	Post-anal	Total	PreAL	PreDFL	HD	BDA	ED	HW	Source
Black Redhorse	35 (26–41)	9 (6–18)	44 (38–49)	64–73	38–48	12–17	8–13	6–7	10–14	This study
Protolarvae	32*	8*	40*	–	–	–	–	–	–	
Mesolarvae	35	9*	44	–	–	–	–	–	–	
Metalarvae	36*	8*	45*	–	–	–	–	–	–	
Black Redhorse	36 (23–41)	7 (3–9)	43 (40–46)	73–76	–	–	8–9	5–6	–	Kay et al., 1994
Protolarvae	40*	5*	43*	–	–	–	–	–	–	
Mesolarvae	37	7*	44	–	–	–	–	–	–	
Metalarvae	35*	7*	42*	–	–	–	–	–	–	
Black Redhorse	35–36	8–9	43–45	–	–	–	–	–	–	Auer, 1982
Greater Redhorse	30	10	40	72–75	32–39	11–12	8–11	7	9–10	Bunt and Cooke, 2004
River Redhorse	35	7	42	72–78	–	–	9–10	5–6	–	Kay et al., 1994
Golden Redhorse	34	6	40	72–74	–	–	9–13	7–10	–	Kay et al., 1994
Shorthead Redhorse	36	8	44	69–79	–	–	–	6–7	–	Fuiman, 1979
Spotted Sucker	33	8	41	69–76	–	–	–	6–8	–	Hogue and Buchanan, 1977
Copper Redhorse	–	–	–	–	–	–	–	–	–	Data not available

Sparse stellate melanophores were present ventrally between the pectoral fins and along the dorsal and ventral midlines of the anterior portion of the yolk sac. The gas bladder became increasingly pigmented by about 14 mm. In unpreserved larvae, yellow chromatophores were visible on the dorsum and above the lateral line.

METALARVAE

Figure 3 (18.1–24 mm TL)

Morphology.—All fin margins were distinct, the pre-anal finfold was not entirely absorbed, and the pelvic fin was developed in metalarvae. For the specimens examined, the caudal fin had 20 principal fin rays, there were five anal-fin rays, and 12 dorsal-fin rays. Although not shown in Figure 3, metalarvae had ten pectoral-fin rays by 18.1 mm. The mouth was fully subterminal by 18.1 mm, the well-developed head was sleek with well-developed nares and a large eye (compared to the size of the head) in a well-developed orbit. The preopercula were transparent in living specimens. Metalarval morphometrics are summarized in Table 1. Specimens had between 34–39 (mean 36) pre-anal myomeres, 7–11 (mean 8) post-anal myomeres, and 42–48 (mean 45) total myomeres compared to the data of Kay et al. (1994) with 34–38 (mean 35) pre-anal myomeres, 5–8 (mean 7) post-anal, and 40–44 (mean 42) total myomeres. Statistical analysis between studies indicated that the differences were significant between pre-anal myomeres ($P = 0.03$), post-anal myomeres ($P < 0.05$), and total myomeres ($P < 0.05$). Myomere data are shown in Table 2 and comparisons are shown in Table 3.

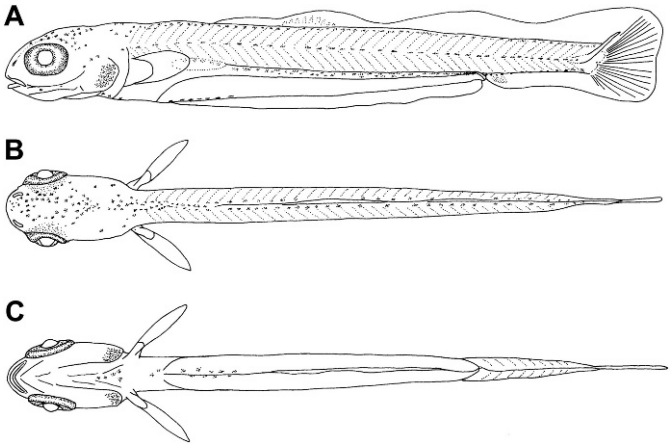

Fig. 2. Lateral (A), dorsal (B), and ventral (C) views of Black Redhorse (*Moxostoma duquesnei)* mesolarvae (15.9 mm TL).

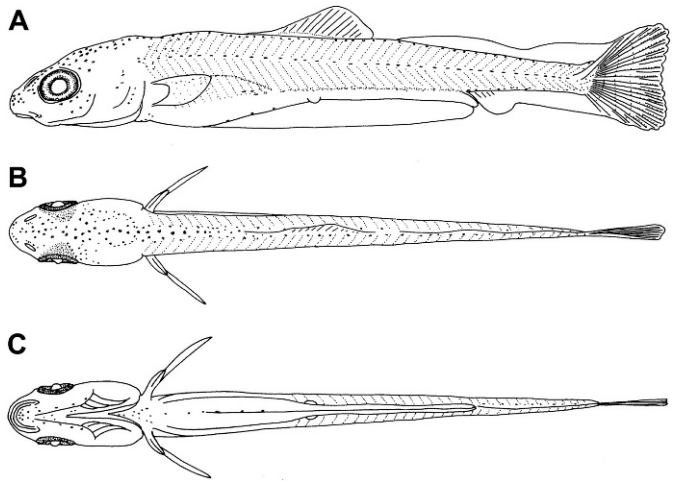

Fig. 3. Lateral (A), dorsal (B), and ventral (C) views of Black Redhorse (*Moxostoma duquesnei)* metalarvae (18.1 mm TL).

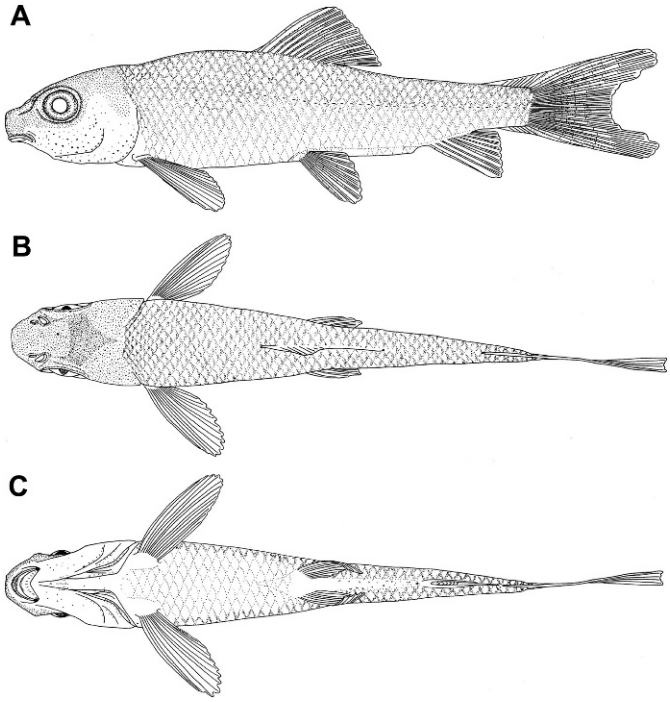

Fig. 4. Lateral (A), dorsal (B), and ventral (C) views of Black Redhorse (*Moxostoma duquesnei*) juveniles (32.5 mm TL, age = 3 months).

Pigmentation.—By 17 mm, numerous large melanophores remained above the lateral midline but fewer large melanophores were present posteriorly. A line of pigmentation was present along the lateral myoseptum, along the ventral midline, and on the dorsal aspect of the head and nape. Melanphores on the occiput appeared to have coalesced into a heart shape. Guanine was sparsely present on the operculum. The iris was golden/silver and the top of the orbit and upper maxillary were densely pigmented, and individuals remained yellow dorsally. Juvenile Black Redhorse (>24 mm) appeared silver during the winter of their first year, and had three saddle-shaped patterns of pigmentation along the body dorsally. Age 1+ Black Redhorse were silver, with well-developed scales and no body pigmentation (Fig. 4). When water temperatures drop below approximately 5°C saddle patterns reappear on juveniles, but fade when temperatures warm again in the spring.

DISCUSSION

The literature on early life history, in particular, egg and larval development, of Black Redhorse is scant, and all literature references are based on the results from one study conducted in 1980 in the Ohio River drainage basin (Kay et al., 1994). This report supports their observations that Black Redhorse >11.2 mm have scattered pigment over the head and occiput that narrows to a predorsal stripe, and lateral melanophores in median myosepta forming a stripe from the pectoral fins to the posterior margin of the yolk sac (Kay et al., 1994). Mesolarval Black Redhorse have a linear pattern of pigmentation along the lateral line on each myomere that distinguishes it from mesolarval Copper Redhorse (*M. hubbsi*), which has a triangular pattern of pigmentation on each myomere along the horizontal myoseptum (Gendron and Branchaud, 1991).

Interspecific morphometric and myomere comparisons among syntopic catostomid species are shown in Table 3.

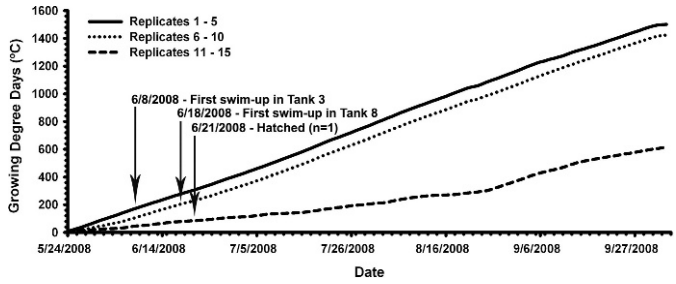

Fig. 5. Cumulative degree-days required for Black Redhorse emergence from spawning substrate. Replicates 1–5 were maintained at approximately 20°C, replicates 6–10 were exposed to ambient river temperatures, and replicates 11–15 were maintained at approximately 10°C.

River Redhorse lack pigmentation until 12.8 mm, after which pigment covers the occiput and nape, and narrows to a median row extending to the origin of the dorsal finfold (Kay et al., 1994). Golden Redhorse >10.8 mm have median pre-dorsal melanophores, and pigmentation increases on the head, occiput, and nape, until larvae are darkly pigmented by 12–14 mm (Kay et al., 1994). Shorthead Redhorse between 10.2–12.2 mm have melanophores on the occiput, a single mid-dorsal row of pigment, and an intermittent mid-lateral stripe (Kay et al., 1994). By 13.2 mm, Shorthead Redhorse have three dorsal stripes that merge into a dark band over the caudal peduncle (Kay et al., 1994). Spotted Sucker have pigmentation along median myosepta at 9.5 mm and a single row of pigmentation dorsally, ventrally, and mid-laterally by 10–11 mm (Kay et al., 1994). Pigmentation differences are usually easy to observe, but should be examined cautiously because significant intraspecific variation may exist, and pigmentation changes can occur depending on method of preservation and age of specimens. Furthermore, artificially reared specimens may be atypical in terms of some pigmentation and anatomical characteristics relative to specimens that are fertilized and develop naturally (R. E. Jenkins, pers. comm.). Water temperature also affects juvenile Black Redhorse pigmentation.

Larval Black Redhorse from the Ohio River drainage basin (Kay et al., 1994) and the Grand River in Ontario have similar numbers of dorsal-, anal-, and caudal-fin rays. Fin-ray counts for Black Redhorse generally overlap with those of Greater Redhorse, Shorthead Redhorse, Golden Redhorse, and River Redhorse, but differ from those of Spotted Sucker (Kay et al., 1994). Morphometric and developmental data of larval Black Redhorse are distinct from those of syntopic species, such as Shorthead Redhorse, Golden Redhorse, Greater Redhorse, River Redhorse, and Spotted Sucker. Black Redhorse mesolarvae have a lower pre-anal length, greater pre-dorsal fin length, greater head depth, and greater head width relative to total length than Greater Redhorse, but there is some overlap in pre-anal length with Shorthead Redhorse and Spotted Sucker. There are insufficient data available for other species to determine if these meristics can be used to reliably distinguish larval Black Redhorse from other syntopic congeners and Spotted Suckers. Knowledge of overlapping species distributions as well as species-specific differences in thermal spawning windows and relative growth rates may also facilitate identification of syntopic larval catostomids.

According to Kay et al. (1994), specimens of *Moxostoma* from the Ohio River drainage basin cannot be reliably distinguished as larvae. However, pre-anal and total myomere counts for the majority of Black Redhorse were unique

compared to other redhorse species with the exception that the total numbers of myomeres for Black Redhorse overlap slightly with those of the Greater, Shorthead, and River Redhorse. There was very limited overlap in numbers of pre-anal and post-anal myomeres among any of the species that were compared. Pigmentation differences, especially around the head, nape, and occiput, as well as pre-anal and post-anal myomere counts may also be used to identify and distinguish larval Black Redhorse as small as 9 mm. Statistical analysis revealed differences among some myomere counts between data from the Grand River and those from the Ohio River drainage. However, mean data from combined larval phases of this study and Kay et al. (1994) fall within the ranges reported in Auer (1982) from the Lake Michigan drainage basin. Therefore, typical myomere counts for larval Black Redhorse within the Great Lakes range from 35–36 pre-anal, 7–9 post-anal, and 43–45 total myomeres (Table 3). Differences may be attributed to geographic variation related to diet, temperature, and/or genetic variation. Further work is necessary to determine if myomere counts alone can be reliably used to separate different species of syntopic *Moxostoma* over a greater geographical range.

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