Observations on the Natural History of the Blue Sucker (Cycleptus elongatus Le Sueur) in the Neosho River

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ABSTRACT: Populations of blue suckers in the Neosho River in Kansas were sampled by electrofishing during the spring and summer of 1976 and 1977. Spawning occurred in deep riffles (1-2 m) with cobble and bedrock substrates in May at water temperatures of 20-23 C. By August, juveniles averaged 125 mm in length. Mature females reach greater maximum ages, weights and lengths (9 years, 4.1 kg, 763 mm T.L.) than males (7 years, 3.7 kg, 749 mm T.L.). In general, adult females were larger than adult males. Condition coefficients vary slightly with time of year. Only a few juveniles were captured, but young blue suckers occupied shallower and less swift water than adults. Laboratory stream observations confirm a preference for smooth substrates in swift current. Food of adults and young consisted primarily of insect larvae and plant material. Blue suckers seem limited by habitat, especially during spawning.

INTRODUCTION

The blue sucker, *Cycleptus elongatus* Le Sueur, is distributed from Montana to Wisconsin and Pennsylvania S to Kentucky, the Gulf of Mexico, Texas and northern Mexico (Alvarez, 1970; Brown, 1971; Clay, 1975; Douglas, 1974; Eddy, 1969; Hubbs, 1957; Smith-Vaniz, 1968). It is found in deep reservoirs (Carlander, 1969; Jenkins, 1953), but its principal habitat is the Mississippi and Missouri rivers and their largest tributaries (Pflieger, 1971, 1975). It also occurs in the Pearl and Rio Grande rivers and tributaries (Contreras and Rivera, 1972).

The blue sucker is considered to be one of the finest of the freshwater food fishes and perhaps the best of the suckers (Coker, 1930; Forbes and Richardson, 1920). It was once an important part of the commercial catch of the Mississippi drainage. In 1899, the Mississippi catch was nearly 1 million kg (Coker, 1930). Today it is scarce in commercial catches. Despite its former abundance commercially, little natural history information about blue suckers has been available (Cross, 1967; Harlan and Speaker, 1956; Miller and Robison, 1973; Pflieger, 1975; Trautman, 1957) and information on age and growth was based on relatively few specimens (Carlander, 1969). Recently, Gilbert (1980) presented North American distributional information and Rupprecht and Jahn (1980) discussed size, growth, reproduction and food habits for Mississippi River blue suckers. We were able to accumulate information on habitat and spawning and complementary data on ages and growth and food habits for blue suckers in the Neosho River.

METHODS

The Neosho River, a tributary to the Arkansas River, drains southeastern Kansas, southwestern Missouri and northeastern Oklahoma. Our collections were from the Neosho mainstream in Labette Co. (juveniles), Lyon Co. (juveniles) and Woodson Co. (adults, spawning riffle) in Kansas. Fish were collected from early April through October in 1976 and 1977 by electrofishing with either a boom-type boat or backpack electrofisher (both D. C.). Blue suckers are very vulnerable to electrofishing, often remaining stunned for minutes after being shocked. Generally, the most effective method was to let the boat drift through deep riffles (1-2m) and return quickly upstream to net stunned fish. In shallow riffles, especially over bedrock, the backpack electrofisher was used with set seines to capture juveniles.

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Total length measurements and weight were taken, adult fish were sexed, scale samples taken from the third and fourth row of the dorsum, the fish tagged with "flag" tags and released. Scales used for age determination were projected and true annuli were considered those with more than one crossover within a complete circulus. Juveniles and some adults were preserved for gonadal examination and food analysis.

Juvenile blue suckers and an adult were kept in a stream aquarium (60 cm X 240 cm) (similar to Brusven, 1973) maintained at 23 C with a 12:12 LD photoperiod. Equal areas (30 cm X 60 cm) of different sized substrates (>2, >8, >16, >32, >64, >128, >256 mm and the smooth bottom of the tank) were placed in water velocities from 0 m/sec to 1.2 m/sec. Four observation periods were made in 48 hr on two juveniles exposed to four substrates with four current speeds. Between trials, substrates were rotated so that eight substrates in four different velocities were available. The total number of observations was 192 (eight substrate rotations X three repetitions X observations X individuals). The number of observations was necessarily limited because of the difficulty of capturing and maintaining juveniles. Observations were made on a single adult (523 mm) kept in the stream aquarium for 2 weeks, but the small dimensions of the laboratory stream prevented experimentation.

RESULTS

Length, weight and condition.—Male blue suckers (n = 38) from the spawning riffle were smaller and weighed less relative to length than did females (n = 38) (Fig. 1). The male length (mm) and weight (g) relationship (least-squares regression) was log W = −.11 + 1.22 (log L) (r = .58) and for females was log W = −5.46 + 3.14 (log L) (r = .94). The relationship for both males and females combined was log W = −1.80 + 1.83 (log L) (r = .73). A functional regression (GM, geometric mean) is more appropriate for fish length-weight relationships (Ricker, 1973), but predictive slopes have been calculated in previous studies of blue suckers. The GM slopes for male, female and both sexes combined were 2.10, 3.34 and 2.51, respectively. The smaller weight in proportion to length for males and significantly different slopes (t-test, < .05) may be related to reproduction. Rupprecht and Jahn (1980) reported that males were not significantly different from females in length-weight in the Mississippi River.

Condition factors (Hile, 1936) reflect a change with time of year that may be associated with reproduction. Condition (expressed as $K = W \times 10^5 / L^3$) was highest for both sexes during May (during spawning), decreased in June and was again greater in August:

	Males	Females
26 May	0.87	0.87
9 June	0.75	0.82
28 August	0.81	0.86

Age and growth.—We captured individuals of all ages and sizes with the exception of fry. With May as the spawning period, young were 100 mm long by midsummer and over 200 mm in the autumn of the 1st year (Table 1). One-year-old blue suckers averaged 266 mm (mean W = 129 g) and 2-year-old suckers, 323 mm (mean W = 213 g). The light upper caudal lobe described for 1st-year fish (Moore and Cross, 1950; Cross, 1967) is also present in 2nd-year blue suckers. Based on projected scales, we found adults to age 9. Females consistently were larger than males at all ages. The largest blue sucker captured was 763 mm TL and weighed 4 kg. Some older fish (age 8) had mean lengths and weights less than younger fish probably because of small sample sizes.

For calculated total lengths at the end of each year of life based on the body-scale relationship, males again were consistently smaller than females (Table 2). Calculated total lengths were slightly smaller than mean total lengths. For juveniles the sizes were comparable but are based on few specimens.

Reproduction.—On 25 April (temp. = 17 C) we captured only tuberculate males on the spawning riffle. The smallest specimen captured (507 mm, 1.02 kg) was sexually mature and age 3. Flow was low and water clarity such that we would have been able to observe spawning. On 26 May (20 C) there had been a large increase in discharge and we were unable to observe individuals because of turbidity, but handled fish easily released milt and eggs. Blue sucker eggs are opaque, slightly yellow, adhesive and average 2.2 mm in diam. Males and females were captured in nearly equal numbers (21 M : 20 F). The major spawning site was an area where the river narrows over bedrock limestone with cobble-sized rocks [modified Wentworth classification after Cummins and Lauff (1969)]. Flow velocity was 1.8 m/sec (depth = 1.43 m).

In early June (23 C) flow was substantially lower over the spawning riffle and only a single individual was present. We electrofished downstream 4 km and found small groups in localized deep riffles. Our attempts to estimate the spawning population density failed because we were unsuccessful in block-netting the high velocity water over the riffles. Also, our recapture rate for tagged individuals was less than 5%. The low

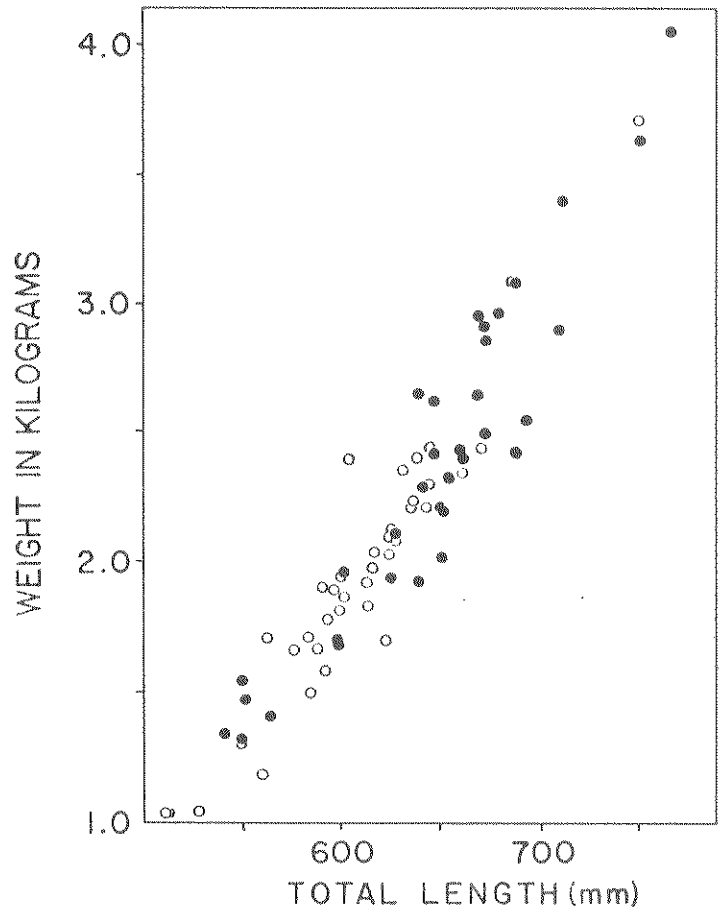

Fig. 1.—Weight vs. length for 72 adult male (open circle) and female (closed circle) blue suckers *(Cycleptus elongatus)* from the Neosho River

percentage may indicate unequal vulnerability of previously captured individuals to electrofishing. All of the individuals captured downstream were unmarked.

Fowler (1912) described the body of blue suckers as finely tuberculated over the entire upper surface in spring. Branson (1962) provided a detailed description of nuptial tubercles over the body and fins and noted that mature specimens taken in middle and late summer were lacking tubercles. In Neosho River blue suckers, tubercles were present from early April until June. Both males and females had many small tubercles on body and fins, but for males tubercles on the snout, around the eyes, and on the opercle were prominent and enlarged (Fig. 2). Male tuberculation provided an easy and consistent method of determining sex during the breeding season. In late June both sexes retained fine body tubercles but genital papillae examination was necessary to determine sex.

Stomach analysis.—Blue sucker stomachs (the first descending section of the intestine) are elongated with highly invaginated walls. One third of both adult (3 of 10) and young (1 of 3) stomachs were empty from fish captured in the afternoon and early evening. Several adults had large numbers of nematodes present (Table 3). Aquatic insects common to the sampled habitat (hellgrammites *Corydalus,* caddisflies *Hydropsyche* and *Cheumatopsyche*) and fingernail clams were found in most stomachs along with filamentous algae (*Cladophora* predominant) and varying amounts of allochthonous leaf litter. Young-of-the-year blue suckers fed on smaller insect larvae (dipterans and caddisflies). The conspicuous absence of odonates and especially mayflies is attributable to the microhabitat used by blue suckers rather than electivity. Invertebrate samples taken from the bedrock and flattened cobble substrates are dominated by an attached filamentous algae fauna with few mayflies (*e.g.*, *Stenonema* and *Baetis*) and lacking odonates.

Physical habitat.—Juveniles kept in a laboratory stream significantly preferred smooth substrates of fine gravel (>2 mm), large cobble (>128 mm) and bedrock

TABLE 1.—Mean total lengths and weights at ages 0 - IX for blue suckers from the Neosho River. The data are from 14 juvenile and 70 adult fish

Capture date	Juveniles	Age
26 May	Spawning	
11 July	90 mm, 5g	
9 August	124 mm, 13g	0
24 October	244 mm, 94g	
2 May	266 mm, 129 g	I
27 May	323 mm, 213 g	II

Adults

Sex		III	IV	V	VI	VII	VIII	IX
F	(mm)	554	563	633	655	681	655	763
	(kg)	1.4	1.6	2.0	2.4	2.8	2.3	4.0
M	(mm)	525	566	601	622	653	647	666
	(kg)	1.1	1.5	1.8	2.1	2.5	2.3	2.3

(>256 mm) (G-test, $p<0.01$). They were observed consistently in the strongest current (1-1.2 m/sec) available over a smooth bottom. Blue suckers are extremely muscular and heavy-bodied and their terete shape and fin placement adapt them to strong currents. In the laboratory stream channels they moved awkwardly over irregular substrates in slower current. Only when over smooth substrates in higher currents were they able to "glide" over the bottom and make feeding movements. It was impossible to produce water velocities sufficient to keep an adult away from outtake tubes in the stream channel. In a discharge greater than 1.2 m/sec, it was able to maintain position with only slight caudal fin movement.

Field captures of young were made over large substrates in shallow swift currents

TABLE 2.—Calculated total lengths (mm) at the end of each year of life of male (M) and female (F) blue suckers from the Neosho River in 1976

Age group	Sex	Number of fish	1	2	3	4	5	6	7	8	9
I		1	252								
II	M	1	185	291							
III	M	3	212	349	449						
	F	2	197	371	472						
IV	M	4	178	354	476	537					
	F	3	205	400	492	553					
V	M	10	192	309	433	506	565				
	F	5	202	412	511	580	614				
VI	M	12	219	335	438	510	568	603			
	F	8	219	356	454	538	597	644			
VII	M	5	198	284	374	448	506	562	608		
	F	12	204	307	400	479	549	603	649		
VIII	M	2	154	242	313	387	455	517	576	617	
	F	2	155	237	305	374	461	526	592	628	
IX	M	1	174	229	282	338	424	483	523	576	620
	F	1	244	400	482	516	570	610	644	674	711
Weighted means	M		198	324	422	491	544	578	589	603	620
	F		205	346	461	512	569	611	641	643	711

TABLE 3.—Stomach analysis for adult and young-of-the-year blue suckers (N = mean number, V = volume percentage, O = frequency of occurrence percentage)

	Adults (n = 10)			Young-of-the-year (n = 3)		
	N(x)	V(%)	O(%)	N(x)	V(%)	O(%)
Nematoda	31	22	66			
Megaloptera						
Corydalus cornutus	15	90	17			
Trichoptera						
Hydropsyche	4	21	17	7	70	100
Cheumatopsyche	2	11	17			
Diptera						
Simulidae				1	2	50
Chironomidae				10	12	100
Pelecypoda						
Sphaerium	2	10	17			
Miscellaneous						
Algae	—	9	17			
Allochthonous	—	2	33			
Fish egg	2	20	17			
Sand	—	14	83	—	10	100

(Table 4). In broad riffle areas (100 m), juveniles were captured in local areas where channel constrictions increased water velocity.

Adults were captured over exposed limestone bedrock in deep riffles typically 1-2 m deep (Table 4). The fastest velocity measured was 2.6 m/sec (at 0.6 depth) with most adults captured in currents greater than 1 m/sec. We have captured individuals over other substrates in shallower riffles, but only one or a few individuals. Concentrations of adults were found in localized areas that maintain deep water even during seasonal low flows.

DISCUSSION

Precise distributional information for a fish like the blue sucker is difficult to obtain. Miller (1972) listed several states in which the blue sucker was considered rare or endangered but these were primarily areas near the periphery of its range. Guillory *et al.* (1978) reviewed endangered fishes in the southeastern U.S. where the blue sucker was classified in nine states. In five of those states its status was considered undetermined.

TABLE 4. — Physical measurements at capture points for young and adult Neosho River blue suckers

	N	Substrate	Depth (m)	Velocity (m/sec)
Young of the year	3	bedrock	.21-.24	.96
Juveniles	2	cobble, bedrock	.31	.81
Prespawning males	8	cobble	.6-.8	.70-1.13
Spawning adults	41	cobble, bedrock	1.1-1.7	.61-2.12
Adults	8	cobble, bedrock	1.1-1.4	1.30-2.10
	15	cobble, bedrock	1.3-2.6	.91-1.60
	7	bedrock	1.3	.6
	1	gravel	.3	.41

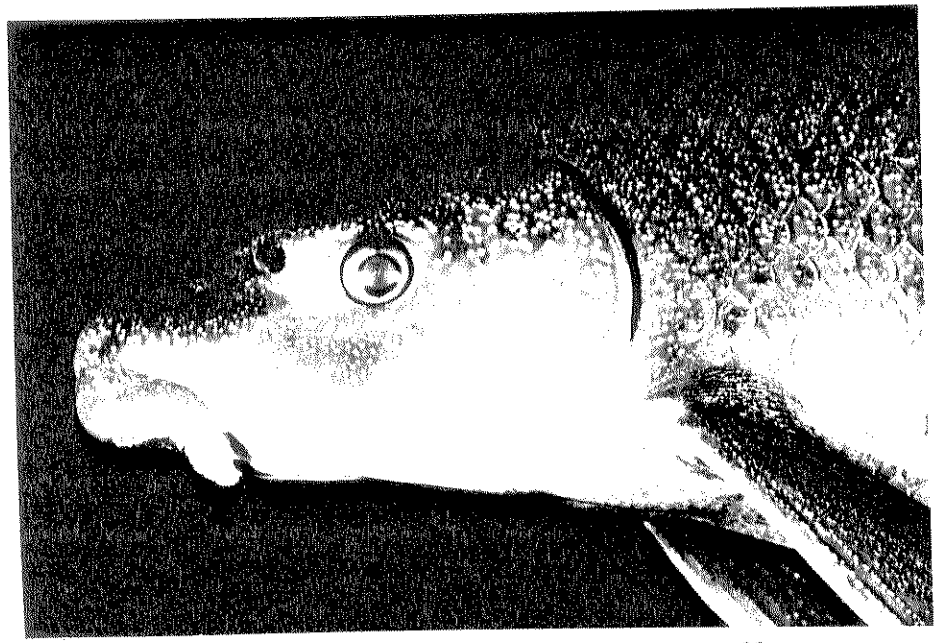

Fig. 2. — An adult male blue sucker with breeding tubercles captured May 26

Smith-Vaniz (1968) believed that the blue sucker is underrepresented in typical survey type collections in Alabama and we believe this is true elsewhere. The Neosho River, especially in Kansas, has been extensively surveyed (Cross, 1967), but our collections in Labette Co. were new locality records because we electrofished in high velocity waters that are difficult to sample by conventional methods.

The preferred habitat of the blue sucker has been affected by construction activities of many types. Blue suckers are often now associated with man-made structures such as reservoir stilling basins, dam bases, bridge abutments, the ends of wing dykes and other flow control structures, all habitats usually not sampled because of the difficulty or the potential damage to equipment. Rupprecht and Jahn's (1980) collections from Mississippi River Pool 20 were also from these types of habitat. This association with structures, of course, decreases in smaller tributaries.

Among probable causes proposed for blue sucker declines are pollution and siltation (Trautman, 1957). Coker (1930), Cross (1967) and others have noted that the destruction and inundation of spawning habitat and blocked migration is a factor. We would agree with Pflieger (1971) that the presence of blue suckers in highly turbid reaches of the Missouri and Kansas rivers indicates that siltation alone is probably not sufficient to exclude blue suckers. These reaches still provide deep, swift areas with firm substrates that are inhabited. Neosho River features include downcutting across geological strata exposing substantial areas of broad riffle with bedrock substrate. The spawning riffle studied is nearly 2 km in length with substantial deep riffle habitat downstream uninterrupted by dams. It is probably this combination of features which has been reduced in other parts of the original range of the blue sucker.

The general study area and spawning riffle was intensively sampled following 3 years of drought in the 1950s by Deacon (1961). He found almost no blue suckers in the area where we found them to be relatively abundant. However, after drought conditions in 1980 we were unable to capture blue suckers in the same area. They seem to be extremely habitat-selective. The presence of adequate areas of swift, deep water over firm substrates with sufficient spring flows over spawning riffles is probably the most important factor in maintaining populations of blue suckers.

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