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DISTRIBUTION OF UNCOMMON FISHES OF THE BIG SOUTH FORK OF THE CUMBERLAND RIVER TENNESSEE AND KENTUCKY

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ABSTRACT

A recent survey of fishes of 16 tributaries of the Big South Fork of the Cumberland River resulted in range extensions for the mountain brook lamprey (*Ichthyomyzon greeleyi* Hubbs and Trautman), warmouth (*Lepomis gulosus* (Cuvier)), and the freshwater drum (*Aplodinotus grunniens* Rafinesque). Another 10 species were infrequently collected and appeared to have very restricted ranges within the drainage. Most notable among these were the arrow darter, *Etheostoma sagitta* (Jordan and Swain), speckled darter, *Etheostoma stigmaeum* (Jordan), and bigeye chub, *Hybopsis amblops* (Rafinesque). The limited ranges of the ten species within the drainage would appear to make them susceptible to man-induced disturbances. This susceptibility seemed evident with the apparent restriction of the southern redbelly dace (*Phoxinus erythrogaster* (Rafinesque)) in one of the three sites it was known to inhabit.

INTRODUCTION

The Big South Fork of the Cumberland River (BSFCR) is part of the Cumberland River system of Tennessee and Kentucky. The river is formed by the confluence of the New and Clear Fork Rivers in north-central Tennessee and flows approximately 65 kilometers until it empties into Lake Cumberland, Pulaski County, Kentucky. The river flows through a deep gorge surrounded by numerous limestone and sandstone bluffs. The majority of the tributaries originate on the Cumberland Plateau and flow into the gorge. Geologically, the drainage consists of Pennsylvanian Age formation in the Cumberland Plateau region and Mississippian Age formation in the gorge area.

The drainage has long been of ichthyological interest due to its variety of habitats and geographic location. Early fish collections included those of Cope (1870), Kirsch (1893) and Fowler (1906, 1924). Two species of interest reported by Kirsch (1893) were the harelip sucker (*Lagochila lacera* Jordan and Brayton) and the bigeye chub (*Hybopsis amblops* Rafinesque). The harelip sucker has not been collected since and is believed to be extinct. The bigeye chub was believed to be extirpated from the system (Comiskey and Etnier 1972), but was recently collected in Rock Creek (Harker et al. 1979, 1980; O'Bara et al. 1982). Additional studies concerned with the ichthyofauna of the drainage include Shoup and Peyton (1940), Riddle (1975), Winger et al. (1977), and Branson and Schuster (1982).

METHODS AND MATERIALS

Fish collections were made during the spring, summer, and fall of 1981, 1982, and 1983 at 49 sites throughout the BSFCR and Clear Fork drainage. Collection techniques included the use of 120-volt backpack electrofishing equipment and seines. Voucher specimens are located in the Tennessee Technological University fish collection. All scientific and common names follow that of Robins et al. (1980).

RESULTS

Specific collection locations and dates of collections for the infrequently collected species appear in Table 1. An annotated list including each species follows.

PETROMYZONTIDAE-LAMPREYS

Ichthyomyzon greeleyi Hubbs and Trautman-mountain brook lamprey: This species was previously reported from the Little South Fork of the Cumberland River (LSFCR) by Comiskey and Etnier (1972). Ammocoetes (identification confirmed by D. A. Etnier) were collected from 10 sites at the mouth or at sluggish reaches of tributaries. Other streams in the area with similar habitats and physical characteristics were found to be adversely affected by acid mine drainage, oil and natural gas runoff, and other man-induced disturbances. O'Bara et al. (1982) reported iron and aluminum concentrations exceeding 0.4 mg/1 and 0.9 mg/1, respectively, in these streams, which did not contain the mountain brook lamprey.

CYPRINIDAE-CARPS AND MINNOWS

Hybopsis amblops (Rafinesque)-bigeye chub: The bigeye chub was collected in Rock Creek in association with *Etheostoma obeyense* Kirsch. Comiskey and Etnier (1972) reported that the bigeye chub was absent from Rock Creek, LSFCR, and Kennedy Creek. They believed that the species was extirpated from the drainage. Harker et al. (1979, 1980) collected the bigeye chub in Rock Creek and the LSFCR.

Phoxinus erythrogaster (Rafinesque)-southern redbelly dace: The southern redbelly dace was collected only from the headwaters of Laurel Fork of North White Oak Creek. Comiskey and Etnier (1972) reported this species from Crooked Creek (Fentress County, Tennessee) and the LSFCR. Bridge construction immediately upstream of the collection site has destroyed preferred habitat and apparently eliminated this species from this section, but the species was collected upstream of the construction site. It appears that the degradation of habitat has restricted the southern redbelly dace in one of three known sites in the BSFCR drainage.

CATOSTOMIDAE-SUCKERS

Catostomus commersoni (Lacepede)-white sucker: Comiskey and Etnier (1972) reported the white sucker from two tributaries of the New River and White Oak

TABLE 1. *Specific locations, number of specimens collected (in parenthesis), and collection dates for ten uncommon fishes encountered in the Big South Fork of the Cumberland River drainage.*

Species	Locations of Collections	Dates
Ichthyomyzon greeleyi	1. No Business Creek	
	a. mouth, Scott Co., TN (5)	Aug. 17, 1981
	b. at Anderson Cave Branch Scott Co., TN (1)	Aug. 17, 1981
	2. Station Camp Creek	
	a. mouth, Scott Co., TN (14)	Aug. 14, 1981
	b. 5.6 km upstream, Scott Co., TN (3)	Aug. 14, 1981
	c. 1.6 km upstream, Scott Co., TN (1)	April 9, 1982
	3. Grassy Fork—Williams Creek	
	a. mouth, Scott Co., TN (1)	July 15, 1981
	4. Rock Creek	
	a. Wright's Camp, Scott Co., TN (6)	July 23, 1981
	5. Laurel Fork-Station Camp Creek	
	a. mouth, Scott Co., TN (1)	Aug. 14, 1981
	b. mouth, Scott Co., TN (1)	Aug. 10, 1982
	6. Laurel Fork-North White Oak Creek	
	a. mouth, Scott Co., TN (2)	Aug. 11, 1981
	7. North White Oak Creek	
	a. Oneida and Western Railroad Crossing, Scott Co., TN (1)	Oct. 4, 1981
Hybopsis amblops	1. Rock Creek	
	a. Wright's Camp, Scott Co., TN (22)	July 23, 1981
Phoxinus erythrogaster	1. Laurel Fork—North White Oak Creek	
	a. Rt. 154 Bridge, Fentress Co., TN (2)	Aug. 6, 1981
	b. Rt. 154 Bridge, Fentress Co., TN (2)	Sept. 8, 1981
	c. Rt. 154 Bridge, Fentress Co., TN (4)	Oct. 10, 1981
Castostomus commersoni	1. Williams Creek	
	a. near Williams Creek School, Scott Co., TN (2)	July 16, 1981
	2. Station Camp Creek	
	a. 5.6 km upstream, Scott Co., TN (4)	April 9, 1982
	b. 1.6 km upstream, Scott Co., TN (1)	Oct. 7, 1983
	c. 5.6 km upstream, Scott Co., TN (2)	Oct. 7, 1983
Lepomis gulosus	1. North White Oak Creek	
	a. Oneida and Western Railroad Crossing, Scott Co., TN (1)	Oct. 4, 1981
Etheostoma obeyense	1. Rock Creek	
	a. Wright's Camp, Scott Co., TN (24)	July 23, 1981
	b. Pickett State Forest, Pickett Co., TN (11)	July 30, 1981
Etheostoma sagitta	1. Roaring Paunch Creek	
	a. Barthell, McCreary Co., KY (10)	Sept. 25, 1981
	b. Rt. 742 Bridge, McCreary Co., KY (6)	Sept. 25, 1981
Etheostoma stigmaeum	1. Williams Creek	
	a. mouth of Puncheoncamp Creek, Scott Co., TN (8)	Sept. 9, 1981
	2. Station Camp Creek	
	a. 0.8 km upstream, Scott Co., TN (7)	April 1, 1983
	b. headwaters, Scott Co., TN (6)	April 1, 1983
Percina squamata	1. Pine Creek	
	a. mouth, Scott Co., TN (6)	Aug. 11, 1981
	2. North White Oak Creek	
	a. Oneida and Western Railroad Crossing, Scott Co., TN (2)	Oct. 4, 1981
Aplodinotus grunniens	1. North White Oak Creek	
	a. Oneida and Western Railroad Crossing, Scott Co., TN (1)	Oct. 4, 1981
	2. Laurel Fork-Station Camp Chreek	
	a. mouth to 1.6 km upstream, Scott Co., TN (2)	May 31, 1982
	b. mouth to 1.6 km upstream, Scott Co., TN (1)	June 23, 1982

Creek. We have collected the species from Williams Creek and Station Camp Creek. It appears that the species is spottily distributed, being collected in only three of 64 sites sampled by Comiskey and Etnier (1972) and in just two of 49 sites sampled during the present study.

CENTRARCHIDAE-SUNFISHES

Lepomis gulosus (Cuvier)-warmouth: The warmouth has not previously been reported from the system upstream of Lake Cumberland. We collected a single specimen in North White Oak Creek just upstream of the confluence with the BSFCR. It is believed that this was a recruit from Lake Cumberland.

PERCIDAE-PERCHES

Etheostoma obeyense Kirsch-barcheek darter: Within the BSFCR drainage, the range of the barcheek darter is restricted to Rock Creek and the LSFCR (Comiskey and Etnier 1972; Harker et al. 1979, 1980). We collected the species at two locations in Rock Creek.

Etheostoma sagitta (Jordan and Swain)-arrow darter: Comiskey and Etnier (1972) reported the arrow darter from Perkins Creek, a tributary of Roaring Paunch Creek, and theorized that its distribution was due to stream piracy as a result of railroad construction. The species was thought to be endemic to the Cumberland River system upstream of Cumberland Falls (Bailey 1948) and in the Kentucky River drainage (Branson and Batch 1983). We collected the arrow darter at two sites in Roaring Paunch Creek.

Etheostoma stigmaeum (Jordan)-speckled darter: The Speckled darter was reported from Rock Creek, Kennedy Creek, Station Camp Creek, BSFCR, and the LSFCR (Comiskey and Etnier 1972; Harker et al. 1980). We collected it in Williams Creek as well as Station Camp Creek.

Percina squamata (Gilbert and Swain)-olive darter: Comiskey and Etnier (1972) reported this species to be the dominant percid of deep channels in the BSFCR, and they also collected it in the Clear Fork and North White Oak Creek. We found the olive darter in Pine Creek, where it was the only percid collected, and North White Oak Creek. Pine Creek was adversely affected by acid mine drainage, domestic pollution, and channelization (O'Bara et al. 1982).

SCIAENIDAE-DRUMS

Aplodinotus grunniens Rafinesque-freshwater drum: Our collection of the freshwater drum is the first record in the BSFCR drainage. It was collected in North White Oak Creek and Laurel Fork of Station Camp Creek.

DISCUSSION

The ranges of infrequently collected species within the drainage were primarily restricted to the western tributaries of the BSFCR. The poor habitat caused by man-induced disturbances in eastern tributaries have eliminated or reduced many fish and benthic macroinvertebrate communities (O'Bara et al. 1982). The main disturbances in the drainage has been the surface mining of coal resulting in acid mine drainage and siltation. Abandoned mines (surface and deep) have also contributed to the overall decline in environmental quality. Other factors reported to have limited fish communities in the drainage include agricultural runoff, oil and natural gas drilling runoff, domestic and industrial pollution, and low water discharge during dry periods. All of these factors have been reported to be of greater magnitude in eastern tributary watersheds (O'Bara et al. 1982).

Increased environmental degradation in the drainage could eliminate some species, especially those with rigid habitat requirements. The reduced fish communities in heavily impacted eastern tributaries indicate that this problem is evident. The elimination of an uncommonly occurring species such as the southern redbelly dace is also likely if man-induced disturbances are allowed to occur. Additional man-induced disturbances can only escalate the likelihood of the reduction of other species. The establishment of the Big South Fork National River and Recreation Area administrated by the U.S. National Park Service should provide some environmental protection but the area does not include the entire watershed of some important tributaries. Entire watershed control or management may be essential if species with restricted populations are to exist in the BSFCR drainage.

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BLOOD CHEMISTRY PROFILES IN BURSECTOMIZED AND INTACT CHICKENS

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ABSTRACT

Blood chemistry profiles were conducted on bursectomized and normal Hubbard chickens at age 4 weeks through 8 weeks. The bursectomized chickens revealed a trend toward lower levels of blood components in sixteen of the nineteen assays. The lower levels detected could not account for the mortality in the bursectomized chickens.

INTRODUCTION

Chicken thrombocytes and mammalian platelets play similar roles in clotting of the blood and in defense of the organism by their phagocytic ability. The chicken thrombocyte is an oval, nucleated cell (5 x 10 micrometers) (Lucas and Jamroz 1961) and the mammalian platelet is a small fragment (1.5 micrometers) of a much larger cell harbored in the bone marrow (Wintrobe *etal.* 1976). In hemostasis the mammalian platelet aggregates faster (Sekhar and Wynalda 1969) and in response to a wider variety of stimuli than the chicken thrombocyte (Grant and Zucker 1973). Thrombocytes that have engulfed foreign matter such as carbon particles are not impaired in their function of hemostatis (Edmonds 1970).

Using the thrombocyte in studying the disease fighting capabilities of the chicken has the added advantage of considering the functions of the bursa of Fabricius. The bursa arises from the epithelial tissue in the region of the cloaca. The initial study of Glick in 1956 and subsequent studies have confirmed that the avian bursa is essential to antibody production (Glick 1970). In mammals the appendix, sacculus, Peyer's patches and tonsils have been suggested as possible bursal equivalents, (Cooper *et al.* 1972) but current evidence favors the bone marrow or fetal liver or more probably a combination of any of the above. Stem cells arising from the bursa initiate the development of antibody producing lymphocytes in secondary lymphoid organs. The progeny of these cells are called B cells because they are bursal derived cells. Other lymphocytes are called T cells because their precursors are thymus derived cells. T cells are active in graft rejection, cancer defense, and in collaboration with B cells against certain antigens.

Surgical bursectomy of chickens at hatching, or hormonal bursectomy prior to hatching by dipping the eggs in testosterone (Glick and Sadler 1961), inhibits antibody production. However, bursectomy does not retard the phagocytic ability of leukocytes, including thrombocytes (Glick *et al.* 1964). Based on cytoxicity studies with antibodies produced in rabbits against chicken thrombocytes, Grigg *et al.* (1979) found an antigenic difference between thrombocytes from bursectomized (Bx) New Hampshire Red chickens and from intact chickens of the same strain. Antisera produced against Bx birds were more effective in causing cell death in Bx thrombocytes than in normal thrombocytes. These results may indicate either a different determinant on the Bx thrombocyte or greater quantities of the same determinant on the Bx cell than on the normal cell. It could also mean that a determinant on the intact cell is masked by some factor from the cell itself or from the serum.

Macrophages are an essential part of the initiation of antibody production (Fishman 1961: Fishman and Adler 1963). Unanue (1972) showed that when the macrophage engulfs a foreign particle most of the particle is metabolized, however, a small portion remains on the cell surface. Claman (1973) believed that this portion is presented to the lymphocyte for antibody production.

Bursectomized birds exhibit poor growth and high mortality. Their decreased quality of life may be attributed to a deficiency of immunoglobulins, lymphoid germinal centers and plasma cells. The number of white blood cells, the hematrocrit, and the hemoglobin level have been found to be normal in these birds (Glick and Sato 1964). Consequently, they are neither anemic nor leukopenic. Hyperglycemia normally follows adrenalin stimulation. However, this action is reduced to one-half the normal activity in Bx birds (Freeman 1971). This result suggests a hormonal secreting role of the bursa. Chicken embryos which have been hormonally bursectomized have a lower level of alkaline phosphatase in the brain than normal chickens (Glick and Kilgore 1969).

The purpose of this study was to examine components of the blood normally assayed to determine pathophysiological conditions, i. e., uremia or kidney damage, hypo- or hyperglycemia, liver disease, lung disease, gout, multiple myeloma, dehydration, inadequate diet, intestinal malabsorption, parathyroid disease, bone diseases, myocardial infraction, and many other diseases. Any of these conditions could account for the high mortality of bursectomized chickens.

MATERIALS AND METHODS

Eighty-four Hubbard baby chickens were obtained from Edward's Hatchery in Lebanon, Tennessee. Within 24 hours posthatch, 50 chickens were surgically bursectomized (Bx) (Glick 1960). Initially, brooder temperatures were kept at 100°C then lowered 5°C at weekly intervals. They were watered and fed daily with chicken starter (Coop Crumbles).

Blood collected by cardiac puncture from Bx and normal (N) chickens was clotted at room temperature and serum from five groups of Bx and N chickens was stored at −55°C. Assays were repeated at weekly intervals for five weeks beginning with the fourth week posthatch.

The chemistry assays were automated on an existing Technicon SMA 6/60 and 12/60 in the clinical laboratory at the Nashville VA laboratory. A minimum of 2 ml of serum was essential for the SMA 12/60 and 1 ml of serum for the SMA 6/60. Reagents, standards, and quality controls of the clinical laboratory were used. The following is a list of the chemical components analyzed in the chicken serum: glucose, carbon dioxide, sodium, potassium, urea, chloride, albumin, alkaline phosphatase, calcium, cholesterol, creatine phosphokinase, creatinine, glutamic-oxaloacetic transaminase, inorganic phosphorous, lactate dehydrogenase, uric acid, total protein, and total bilirubin. Statistical analysis was by the t test.

RESULTS AND DISCUSSION

A much higher mortality rate was seen in the surgically bursectomized chickens (Bx) than in the normal group (N). In the first three weeks after surgery, approximately 25% of the Bx birds expired compared to about 6% of the N chickens. After the third week most of the deaths were attributed to the trauma of cardiac puncture. At completion of the eight week 50% of the Bx birds and 25% of the N birds had died. The Bx birds had a watery excreta which was not observed in the N birds.

The serum of N birds contained consistently higher total proteins (Table 1) than Bx birds. There was no significant difference in albumin values. Corresponding to the above two values, the calculated globulin values were significantly lower in the Bx birds. Significant differences between N on Bx birds were observed in phosphorus, cholesterol, uric acid, cheatinine, urea and sodium levels.

Immunoglobulins comprise 61% of the globulin fraction in chickens (Altman and Dittmer 1961). Since B lymphocytes and their progeny (plasma cells) produce immunoglobulins, bursectomy early in life produces a deficiency of these cells and their products. This study strengthens the theory of the bursal influence of antibody production.

Unlike mammals which eliminate unwanted nitrogen by way of urea, chickens rid themselves of nitrogen by way of uric acid. Probably the sole source of urea in fowl blood is dietary nitrogen (Bell and Freeman 1971). In man creatinine is normally excreated in the urine. Creatine concentration is very low or absent. Chickens, however, lack a creatine dehydrating mechanism and thus excrete creatine but very little creatinine (Bell and Freeman 1971). As one would expect the present study revealed very little creatinine in the blood of the chickens.

Since the Bx birds had a watery excreta and the N birds had more components with higher concentrations. The Bx bird may be unable to concentrate its excreta as well as the N bird. The absence of a bursa posterior to the cloaca may affect the ill-defined function of water reabsorption in the cloaca.

Another possibility is that the deficiency of antibodies could cause a chronic gastrointestinal problem. *Giardia lamblia* is a common pathogenic agent in humoral immune deficiency in man (Ferguson and MacSween 1976). The bursa of Fabricius functions as a lymphoid organ that seeds immunocompetent cells to secondary lymphoid organs. Locally, the bursa functions as a site for antibody production against bacteria that reside in the cloaca (Van Alten and Meuwissen 1972). Since ureters, oviduct, and bursa empty into the cloaca, it has been speculated that a possible role of bursal antibody is the control of genitourinary tract infections (Waltenbaugh and Van Alten 1974). In the present study, urinary infections or irritations might have caused a decreased urine concentrating ability in the Bx birds.

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TABLE 1. *Blood chemistry profile of Normal and Bursectomized chickens between four and eight weeks post-hatch.*

Assay[1]	Normal	Bursectomized
Total Protein (gm%)	3.49 ± 0.05	3.13 ± 0.06**
Albumin (gm%)	1.02 ± 0.03	1.00 ± 0.02
Globulin (gm%)	2.46 ± 0.05	2.12 ± 0.04**
Calcium (mg%)	10.00 ± 0.16	9.60 ± 0.10
Phosphorus (mg%)	5.86 ± 0.14	5.34 ± 0.18*
Cholesterol (mg%)	200.00 ± 7.00	174.00 ± 6.00
Uric Acid (mg%)	5.80 ± 0.40	4.50 ± 0.30*
Creatinine (mg%)	0.33 ± 0.02	0.27 ± 0.01*
Urea (mg%)	1.00 ± 0.01	0.60 ± 0.01*
Total Bilirubin (mg%)	0.30 ± 0.02	0.30 ± 0.02
Glucose (mg%)	267.00 ± 4.00	263.00 ± 2.00
Alkaline Phosphatase (mU/ml)	2826.00 ± 321	2408.00 ± 147
Creatine Phosphokinase (mU/ml)	2649.00 ± 219	2914.00 ± 299
Lactate Dehydrogenase (mU/ml)	983.00 ± 90	912.00 ± 74
Glutamic Oxaloacetic Transaminal (mU/ml)	291.00 ± 11	208.00 ± 3.00
Sodium (meq/l)	152.00 ± 1.0	148.00 ± 1.0*
Potassium (meq/l)	5.50 ± 0.1	5.30 ± 0.1
Chloride (meq/l)	120.00 ± 1.0	116.00 ± 1.0
CO_2 (meq/l)	24.00 ± 1.0	24.00 ± 1.0

[1]Each value represents the mean of 25 assays ± SE.

Significant difference at p = 0.05 (*) or 0.01 (**) level of confidence as determined by *t* test.