TEXAS J. SCI. 55(4):323-328 NOVEMBER, 2003

GUT CONTENT ANALYSIS OF THE HEADWATER CATFISH *ICTALURUS LUPUS* FROM TWO WEST TEXAS STREAMS

Bradley M. Littrell, Chad Thomas, Casey S. Williams and Timothy H. Bonner
Department of Biology/Aquatic Station
Texas State University-San Marcos
San Marcos, Texas 78666

Abstract.—Gut contents of headwater catfish *Ictalurus lupus* were examined from Independence Creek (Pecos River drainage) and Dolan Creek (Devils River drainage) of west Texas. Gut contents consisted of algae and detritus (85%), aquatic insects (9%), crustaceans (3%) and other aquatic and terrestrial organisms (3%). Algal cell walls were ruptured in the lower intestines of *I. lupus*, suggesting plant nutrients were obtained. Aquatic insects and crustaceans were more prevalent in younger fish than older fish, and less abundant in fish from Dolan Creek than those from Independence Creek. Fewer insects and crustaceans in fish from Dolan Creek may be a result of competition with the introduced smallmouth bass *Micropterus dolomieu*. However competition, if present, did not equate into lower condition factors ($P>0.05$) for *I. lupus*.

Ictalurus lupus is endemic to the Colorado, San Antonio, Nueces and Rio Grande drainages of Texas and Mexico (Conner & Suttkus 1986; Lundberg 1992). Habitat alterations and competitive interactions with the sympatric *I. punctatus* led to their extirpation from Gulf slope streams of Texas (Kelsch & Hendricks 1990) and range reduction in the Rio Grande drainage of New Mexico (Sublette et al. 1990). Currently, *I. lupus* inhabits clear, headwater streams in the Rio Grande drainage of New Mexico, Texas and Mexico, and Gulf slope streams of northeastern Mexico (Kelsch & Hendricks 1986; Sublette et al. 1990).

Ictalurus lupus is listed on the Texas Organization of Endangered Species watch list (Hubbs et al. 1991), considered threatened by Hubbs et al. (1991), and listed as a critically imperiled species in New Mexico (New Mexico Natural Heritage Program 1997). Anthropogenic modifications of stream habitats and possible hybridization with *I. punctatus* continue to threaten existing populations of *I. lupus* (cf. Kelsch & Hendricks 1986; Kelsch & Hendricks 1990; Hoagstrom 2003). Unfortunately, little is known about their general life history to aid in management and conservation. The objective of this study was to describe gut contents for *I. lupus* collected from two streams in west Texas: Independence Creek (Pecos River drainage, Terrell County) and Dolan Creek (Devils River drainage, Val Verde County).

METHODS AND MATERIALS

Ictalurus lupus were collected with seines from Independence Creek (n = 25; range = 86 - 250 mm in total length) and Dolan Creek (n = 17; range = 127 - 309 mm in total length) in July 2002 and preserved in 10% formalin. In the laboratory, number of anal fin rays, pectoral spine length, mouth width and caudal peduncle depth were used to confirm identification following the methods described by Kelsch (1995). Total length (mm) and weight (g) of each fish were recorded and the alimentary canal from the esophagus to the anus was removed.

Contents of the stomach and intestine were extracted and weighed. Food items (invertebrates and fish bones) and parasites were sorted and identified to the lowest practical taxon, counted, and weighed to the nearest mg. Remaining gut contents, primarily filamentous algae with some unidentifiable organic and inorganic detritus, were weighed. Percent occurrence (percentage of catfish with each food item present) was determined for all taxa. Mean number of each taxonomic group was determined for animal taxa. Percent weight (100 * taxon weight/total content weight) was determined for all taxa and averaged among catfish to obtain mean percent weight for each taxon.

RESULTS AND DISCUSSION

Filamentous algae and detritus were found in 98% of the catfish and represented 85% (mean percent by weight) of gut contents (Table 1). Filamentous algae were dark green in color with intact cell walls in the stomach but faded to light green or brown with ruptured cell walls in the lower portion of the intestines near the anus, suggesting nutrients were derived from the algae (Jobling 1995). Aquatic insects (Coleoptera, Diptera, Ephemeroptera, Hemiptera, Lepidoptera, Odonata and Tricoptera) were found in 83% of the catfish and represented 9% of gut contents weight. Hemiptera formed the largest percentage (4%) of aquatic insects by weight, Diptera were most frequently encountered (in 45% of the fish), and Lepidoptera were the most numerically abundant aquatic insects (mean = 2.8 organisms per fish). Crustaceans (Amphipoda, Decapoda & Podocopida) were in 38% of the catfish and represented 2.8% of gut contents weight. Decapoda formed the largest percentage (2%) of crustaceans by weight and Amphipoda were the most frequently encountered (29%) and numerically abundant (mean = 1.3 organism per fish) crustacean. Fish and Hydracarina were in one catfish each and composed $<$0.5% by weight and $\leq$2% in occurrence. Molluscs (Gastropoda and Bivalvia) were in 19% of the catfish and repre-

Table 1. Percent occurrence, mean number per catfish and mean percent weight of food items and parasites found in the alimentary canal of *Ictalurus lupus* (n = 42) collected from Independence and Dolan creeks, July 2002.

	Percent occurrence	Mean number per fish	Mean % by weight
Algae/Detritus:	98		85.2
Aquatic insects:			
Coleoptera	24	0.6	0.3
Diptera	45	1.3	0.5
Ephemeroptera	26	0.4	0.5
Hemiptera	21	0.7	4.1
Lepidoptera	38	2.8	1.3
Odonata	7	0.1	1.6
Trichoptera	7	0.1	0.5
Unidentified	5	0.07	0.5
Crustaceans:			
Amphipoda	29	1.3	0.7
Decapoda	10	0.1	2.1
Podocopida	5	0.05	<0.1
Fish bones	2	0.05	0.2
Hydracarina	2	0.02	<0.1
Mollusca:			
Bivalvia	2	0.02	0.02
Gastropoda	19	0.5	1.2
Parasites:			
Acanthocephala	21	0.95	0.01
Cestoda	2	0.02	0.07
Trematoda	45	3.6	0.5
Terrestrial organisms	7	0.1	0.8

sented 1% of gut contents by weight. Terrestrial organisms (Araneae, Isopoda) were in 7% of the catfish and represented <1% of gut contents weight.

Following the trophic guild classification of Goldstein & Simon (1999), *I. lupus* is a particulate herbivore and benthic invertivore based on large amounts (96% by weight) of algae and aquatic invertebrates in the gut contents. However, the presence of fish and terrestrial arthropods suggested carnivorous and opportunistic feeding behavior. Ictalurids in general consume a variety of food items. Three species of *Ameiurus* are classified as benthic invertivores, particulate herbivores, and carnivores (Goldstein & Simon 1999). *Ictalurus furcatus* and *I.*

punctatus (the closest extant congener to *I. lupus*; Lundberg 1992) are benthic invertivores and carnivores. Algae and other vegetation is not a major food item in the diet of *I. punctatus* (Bailey & Harrison 1945; Mathur 1971; Walburg 1975; Hill et al. 1995), but may be consumed in high abundance seasonally, incidentally, or dependent on availability of other food items (Bailey & Harrison 1945; Busbee 1968). Seasonality and food availability were not assessed so the importance of algae and detritus in the gut contents of *I. lupus* is unknown; it may be dependent on season or availability of other food items. Alternatively, difference in diets between *I. lupus* (particulate herbivore and benthic invertivore) and *I. punctatus* (benthic invertivore and carnivore) may indicate food partitioning between two sympatric species that tend to inhabit longitu-dinally different areas of the same drainage basin.

Intestinal parasites were in 45% of the fish, 65% in catfish from Independence Creek and 18% in catfish from Dolan Creek. Trematoda was the most common and abundant parasite, occurring in 45% of the catfish (mean = 3.6 per fish, range = 1 – 29), followed by Acanthocephala (21%, mean = 0.95 per fish, range = 1 – 12) and Cestoda (2%, found in one fish). Although parasites were common in the intestines of *I. lupus*, their frequency and intensity were not unusual for fishes (Ryon 1986; Nie et al. 1999). Parasite loads of up to 300 trematodes per fish have been found in *I. punctatus* from the Little Brazos River, Texas, with 100% of the fish infected at certain times of the year (Dronen et al. 1982). In addition, no evidence was found that fish were negatively affected (e.g., emaciated) by the infestation levels observed here.

Proportion of food items among four categories (algae/detritus, aquatic insects, crustaceans, and other) by weight differed ($X^2_3 = 16.8$, $P < 0.01$) between smaller (86 – 162 mm) and larger *I. lupus* (179 – 309 mm). Smaller catfish contained less algae and detritus (78%) and more aquatic insects (13%) and crustaceans (4%) compared to larger catfish (94%, 4% and 0.7% respectively). These differences suggest a diet shift between younger and older fish, which is common in ictalurids (Busbee 1968; Jearld & Brown 1971) and for species in which adults feed primarily on plants or algae with the young displaying carnivorous habits (Gerking 1994).

Diets of *I. lupus* differed ($X^2_3 = 14.7$, $P < 0.01$) between Independence Creek and Dolan Creek. Dolan Creek catfish consumed greater amounts of algae and detritus (91% by weight), and lesser amounts of aquatic insects (5%) and crustaceans (0.6%) compared to those from Independence Creek (85%, 10%, and 4% respectively). Mean total lengths (± *SD*) were 188.8 (± 57.97) mm for catfish from Dolan Creek and 164.1 (± 42.62) mm for catfish from Independence Creek. However, total lengths were not different ($t_{0.5\ (2),\ 40} = 1.59$, $P = 0.12$) between streams. Thus, diet differences were unrelated to catfish size between streams. Other plausible explanations for diet differences include habitat and food availability differences between sites and possible interspecific competition for macroinvertebrates between *I. lupus* and the introduced *M. dolomieu* in Dolan Creek, an aggressive invertivore in Dolan Creek and the Devils River (Robertson & Winemiller 2001). Lesser amounts of aquatic insects and crustaceans in Dolan Creek fish did not result however in lower condition or slower growth. Fulton condition factors (100,000 x W x TL^{-3}; range = 0.8 - 1.2) did not differ ($t_{0.5\ (2),\ 40} = 0.86$, $P = 0.41$) between the two populations, nor did length-weight relationships (analysis of covariance; $F_{1,\ 39} = 0.6$, $P = 0.44$). Weight as a function of length pooled across collection sites was described by the linear model: $\log_{10}$ weight (g) = -4.82 + 2.92 * ($\log_{10}$ length) ($P < 0.001$, $R^2 = 0.99$).

Acknowledgments

The Nature Conservancy and Texas Parks and Wildlife Department provided financial support. J. P. Karges and J. C. Wrinkle (The Nature Conservancy's Lower Pecos Project Director) granted stream access for collections. We thank A. F. and A. A. Echelle for inviting us on their *I. lupus* expedition. J. R. Watson and C. L. Hooker assisted in field collections and laboratory analyses. Joe N. Fries, Gary P. Garrett, and an anonymous reviewer provided beneficial comments on early versions of this manuscript.

Literature Cited

Bailey, R. M. & H. M. Harrison, Jr. 1945. Food habits of the southern channel catfish *Ictalurus lacustris punctatus* in the Des Moines River, Iowa. Trans. Am. Fish. Soc., 75:110-138.

Busbee, R. L. 1968. Piscivorous activities of the channel catfish. Prog. Fish Cult., 30:32-34.

Conner, J. V. & R. D. Suttkus. 1986. Zoogeography of freshwater fishes of the western gulf slope of North America. Pp. 413-456, *in* The zoogeography of North American freshwater fishes (C. H. Hocutt & E. O. Wiley, eds.), John Wiley & Sons, New York, viii+866 pp.

Dronen, N. O., Jr., H. T. Underwood & L. A. Rubec. 1982. Seasonal fluctuations in the population density of *Alloglossidium corti* (Digenea: Macroderoididae) in channel catfish from the Little Brazos River, Texas. Southwest. Nat., 27(1):73-78.

Gerking, S. D. 1994. Feeding ecology of fish. Academic Press, San Diego, California, xxvi+416 pp.

Goldstein, R. G. & T. P. Simon. 1999. Toward a united definition of guild structure for feeding ecology of North American freshwater fishes. Pp 123-202, *in* Assessing the sustainability and biological integrity of water resources using fish communities (T. P. Simon, ed.), CRC Press, Boca Raton, Florida, ix+671 pp.

Hill, T. D., W. G. Duffy & M. R. Thompson. 1995. Food habits of channel catfish in Lake Oahe, South Dakota. J. Fresh. Eco., 10:319-323.

Hoagstrom, C. W. 2003. Historical and recent fish fauna of the lower Pecos River. Pp 91-110, *in* Aquatic fauna of the Northern Chihuahuan Desert (Garrett, G. P. & N. L. Allen, eds.), Special Publications, Museum, Texas Tech Univ., viii+160 pp.

Hubbs, C., R. J. Edwards & G. P. Garrett. 1991. An annotated checklist of the freshwater fishes of Texas, with keys to identification of species. Texas J. Sci., Supp. 43(4):1-56.

Jearld, A. & B. E. Brown. 1971. Food of the channel catfish (*Ictalurus punctatus*) in a southern Great Plains reservoir. Amer. Midl. Nat. 86:110-115.

Jobling, M. 1995. Environmental biology of fishes. Chapman & Hall, New York, xiii+455 pp.

Kelsch, S. W. 1995. Patterns of morphometric variation in the channel and headwater catfishes. Trans. Am. Fish. Soc., 124:272-279.

Kelsch, S. W. & F. S. Hendricks. 1986. An electrophoretic and multivariate morphometric comparison of the American catfishes *Ictalurus lupus* and *I. punctatus*. Copeia, 1986:646-652.

Kelsch, S. W. & F. S. Hendricks. 1990. Distribution of the headwater catfish *Ictalurus lupus* (Osteichthyes: Ictaluridae). Southwest. Nat., 35(3):292-297.

Lundberg, J. G. 1992. The phylogeny of Ictalurid catfishes: a synthesis of recent work. Pp. 392-420, *in* Systematics, historical ecology and North American freshwater fishes (R. L. Mayden, ed.), Stanford Univ. Press, xxvi+969 pp.

Mathur, D. 1971. Food habits and feeding chronology of channel catfish *Ictalurus punctatus* (Rafinesque), in Conowingo Reservoir. Proc. Southeast. Assoc. Game Fish Comm., 24:377-386.

New Mexico Natural Heritage Program. 1997. New Mexico Heritage State Ranks, October 1997. Albuquerque, NM.

Nie, P., W. J. Yao, Q. Gao, G. T. Wang & Y. A. Zhang. 1999. Diversity of intestinal helminth communities of carp from six lakes in the flood plain of the Yangtze River, China. J. Fish Biol., 54:171-180.

Robertson, M. S. & K. O. Winemiller. 2001. Diet and growth of smallmouth bass in the Devils River, Texas. Southwest. Nat., 46(2):216-221.

Ryon, M. G. 1986. The life history and ecology of *Etheostoma trisella* (Pisces: Percidae). Amer. Midl. Nat., 115:73-86.

Sublette, J. E., M. D. Hatch & M. Sublette. 1990. The fishes of New Mexico. Univ. of New Mexico Press, Albuquerque, xiii+393 pp.

Walburg, C. H. 1975. Food of young-of-year channel catfish in Lewis and Clark Lake, a Missouri River Reservoir. Amer. Midl. Nat., 93:218-221.

THB at: TBonner@txstate.edu