FOOD HABITS OF YOUNG STRIPED BASS *ROCCUS SAXATILIS* (Walbaum), IN CULTURE PONDS[1,2]

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ABSTRACT

Food of striped bass 10 mm. to 110 mm. standard length cultured at the State Fish Hatchery, Durant, Oklahoma was determined during the summer of 1967. Diet of fish in the 10 mm. to 30 mm. class consisted mainly of copepods, supplemented by cladocera and insects. After reaching 30 mm., bass utilized fewer copepods but more cladocera and more insects. Insects and cladocera then formed the majority of the diet in fish from 60mm. to 100mm.

Over two-thirds of the volume of planktonic crustacea eaten were *Diaphanosoma* sp. Other important crustacea were *Diaptomus* sp. and *Daphnia* sp.

Fish did not enter the diet until bass reached 69mm. standard length and fish were not important in the diet until bass were over 90mm.

No monthly variations in feeding habits were detected.

The culicid, *Chaoborus* sp. was also a significant food item of the smallest length class examined.

INTRODUCTION

An analysis of food availability and utilization in Oklahoma culture ponds was conducted to determine preferred food organisms of striped bass, *Roccus Saxatilis* (Walbaum), ranging from 10 mm. to 109 mm. standard length. Cladocera, copepods and various insect larvae comprised over ninety percent of the diet of fish in this study. However, fish in various length classes exhibited preferences for certain food organisms.

Striped bass were originally isolated from a marine environment with the construction of Santee-Cooper Reservoir, South Carolina in 1941. Striped bass were captured in the lake upon impoundment (Stevens, 1957). With the resulting success of sport fishing in this lake, other states became interested in attempting to establish the species in fresh water lakes throughout the United States. Most of the early attempts were made with adult fish in efforts to produce natural production. Many of these attempts were thwarted by handling problems encountered in transporting large striped bass (Surber, 1957; Gray, 1957).

Ensueing efforts have been made by stocking large numbers of striped bass fry in reservoirs to establish a fishable propulation. This program has been unsuccessful in most areas although one established population has been reported in Kerr Reservoir, North Carolina (Sandoz and Johnston, 1965). This population was established only after extensive stocking of large numbers of fry. Sandoz and Johnston (1965) suggested that rearing young striped bass to larger sizes in culture ponds could shorten the necessary period of stocking due to better survival of the introduced fish.

Several agencies have initiated programs of rearing fingerling striped bass in hatchery ponds. Success has been varied with no apparent reasons for many of the failures. As information has been gathered and hatchery personnel have become more familiar with this species, successes are becoming more prevalent.

Many food habit studies have been conducted on wild populations of striped bass. Most of these studies, Stevens (1957), Raney, et. al. (1957) and Thomas (1967) were concerned with food habits of adult fish in their natural environment. Heubach, Toth, and McCready (1963) conducted an extensive study of food of young-of-year striped bass in the brackish water of the Sacramento-San Joaquin River systems of

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California. The results of their study show the utilization of many marine planktonic species which do not occur in fresh water environments. Regan, Wellborn and Bowker (1968) conducted an availability and utilization study of zooplankton at the Edenton, North Carolina National Fish Hatchery. They found young striped bass exhibit a strong preference for the copepod *Cylops* sp. and selected against *Ceriodaphnia* sp.

PROCEDURES

All culture ponds were filled with surface water filtered through 52 mesh per inch saran screen. Insect control was unsuccessfully attempted with 1.5 parts per million Dylox. Karmex, a herbicide, was used to control aquatic vegetation. Alfalfa meal pellets were used for fertilization of produce a zooplankton bloom in the shortest possible time. A mixture of two parts diesel oil and one part gasoline was applied to the ponds for control of predaceous insects. This method produced some control although insects were still abundant in all ponds.

Striped bass fry were received from South Carolina and Virginia in April, 1967. Fry were held in 45 gallon aquaria until swimming horizontally and mouth parts were fully developed i.e., five to seven days old. At this time the postlarval fish were stocked into two-acre culture ponds. Stomach, plankton, and benthos samples were taken from the ponds periodically. After thirty days fish were taken from the two-acre ponds and stocked into nineteen, one-tenth acre ponds at 200 fingerlings per pond. These fingerlings averaged 35 mm. standard length. Bi-weekly sampling was then initiated in all ponds.

Fifteen test ponds received commercial fish food daily. Throughout the study nine ponds were supplied with adequate forage fish including: fathead minnows *(Pimephales promelas)*; mosquitofish *(Gambusia affinis)*; red shinner *(Notropis lutrensis)*; Mississippi silversides *(Menidia audens)*; *Tilapia mossambica; T. zillii*; and *T. nilotica*. Due to malfunctions of screening structures gizzard shad, *Dorosoma cepedianum,* and sunfish *(Lepomis* sp.) gained entry to some ponds. The remaining eight ponds received periodic fertilization only to produce a zooplankton bloom.

Samples of striped bass taken from each pond with a 100-foot seine were immediately preserved in ten percent formalin. Stomachs were removed and contents flushed into a petri dish for microscopic examination. Food organisms were identified to genus when possible according to Ward and Whipple (1959) and Pennak (1953). Counts were made to determine the number of each organism in each stomach and the percent volume estimated by item.

Twenty gallons of pond water was filtered through Number 25, silk bolting cloth to collect plankton samples. Benthos samples were collected with a six inch square Ekman dredge. All samples were preserved in ten percent formalin and identified to genus according to Ward and Whipple and Pennak.

RESULTS

Culture ponds treated in the above manner produced planktonic organisms ranging from 98 to 747 organisms per liter (Table I). Bottom organisms ranged from 86 to 287 per square foot with *Tubifex* and *Chironomus* being the most prevalent (Table II).

Striped bass under 30 mm. consumed greater volumes of copepods than all other food organisms (Table III). Copepods occurred less frequently than expected in the 10 mm. to 19 mm. size range, but percent frequency of occurrence remained high until fish attained 50 mm. length (Table IV). Percent number of copepods per stomach dropped drastically after reaching 29 mm. length (Table V). The copepods occurring in striped bass stomachs were *Diaptomus* sp. and *Cyclops* sp.

Cladocerans become very important in the striped bass diet at 30 mm. to 89 mm. length. The three cladocerans most represented in the stomachs were *Diaphanosoma* sp., *Moina* sp. and *Ceriodaphnia* sp. These organisms appeared in most of the stomachs sampled in the study.

Insecta was important volumetrically throughout the study. Percent number of organisms were very low but frequency of occurrence was high. Several species of

TABLE 1.
Average number of planktonic organisms per liter.

Organism	*5/17/67*	*6/27/67*	*7/24/67*	*8/09/67*
		Date		
Cladocera:				
Diaphanasoma		1.91	7.28	13.76
Moina	0.61	20.64	0.19	
Ceriodaphnia	0.08	27.13	10.73	10.56
Simocephalus			0.19	
Daphnia		5.67		0.32
Scapholeberis		1.39	0.41	
Bosmina		132.56	1.77	10.88
Copepoda:				
Diaptomus	5.19	32.79	8.49	17.76
Cyclops	0.38	8.21	0.65	1.76
Nauplii	5.19	79.39	40.04	38.04
Rotifera	80.26	427.61	22.90	9.92
Ostracoda	0.31		0.47	0.16
Ceratapogonidae	0.08			
Nematoda	0.08			
Arachnida	0.08			
Planaria		0.09		
Algae	36.88	9.93	4.42	9.28
Total	129.14	747.32	97.54	112.44
No. Samples	11	19	9	10

TABLE 2.
Average number of bottom organisms per square foot.

Food Items	*5/24/67*	*6/12/67*	*6/27/67*	*7/27/67*	*8/10/67*
Tubifex	25.23	56.28	88.50	164.52	158.00
Chironomus	122.77	21.45	15.25	3.13	4.77
Chaoborus	0.31	5.86	2.75	1.22	0.31
Neuroptera	1.38	1.79	6.50	0.09	0
Hirudidea	0	0.41	1.50	0.26	0.31
Ephemeroptera	0	0.34	1.25	0.09	0.15
Odonata	0	0	0	0.61	1.23
Total	149.69	86.13	115.75	169.92	164.77
No. Samples	13	29	8	23	13

TABLE 3.
Estimated percent volume of each food organism by standard length class of fish.

Item Eaten	*10-19mm*	*20-29mm*	*30-39mm*	*40-49mm*	*50-59mm*	*60-69mm*	*70-79mm*	*80-89mm*	*90-99mm*	*100-109mm*	*Total Organism*	*Stomachs Containing Organism*
Cladocera												
Diaphanosoma	17.2	3.0	9.1	9.3	32.9	34.6	25.5	19.6	0.2		30,240	103
Moina	4.0	4.7	18.8	21.6	5.3	4.7	4.4	0.2			9,091	62
Ceriodaphnia		3.4	3.1	9.6	4.4	2.3	2.9				4,091	32
Alona		5.4	2.7	0.1							292	18
Simocephalus				0.5	6.8	0.8	1.9				729	17
Daphnia	0.8	0.2	2.7			<0.1	2.9	0.3			768	14
Bosmina		1.6	0.2	1.1	0.1		<0.1				480	15
Macrothrix		1.8	0.2								104	4
Unid. Clad.	0.9	<0.1		1.8	3.8						17	7
Total Clad.	22.9	20.1	36.9	44.0	53.3	42.4	37.6	20.0	0.2		45,812	190
Copepoda												
Diaptomus	48.5	17.7	15.7	3.6	14.0	7.1	0.2	0.5			3,930	147
Cyclops	0.5	9.0	5.4	4.1	0.2	0.1	0.1				1,239	28
Nauplii	2.3	10.9									1,661	17
Unid. Cop.	7.3	3.5		2.7		<0.1					347	13
Total Cop.	58.6	41.1	21.1	10.4	14.2	7.2	0.3	0.5			7,177	191
Insecta												
Chironomidae	2.9	17.3	9.9	23.6	2.9	2.9	1.9	7.9			315	75
Odonata			3.3	16.8	3.3	7.8	21.6	14.9		15.0	100	31
Ephemeroptera		10.0	7.9	2.7	13.0	8.0	5.6	5.0			154	42
Notonectidae					6.9	11.3	10.5	6.0			112	20
Culicidae	14.0	1.8	0.1	0.2	3.5						40	29
Trichoptera						6.9	4.3	20.7	20.0		157	12
Corixidae		0.5	3.1				5.5	4.3	12.0		31	9
Ceratopogonidae			1.9	<0.1		1.7	<0.1				26	7
Unid. Insects		2.7	5.3	1.8	0.7	6.7	3.9	2.1	40.0		47	25
Total Insects	16.9	32.3	31.5	45.2	30.3	45.3	53.4	60.9	72.0	15.0	982	250
Annelida		4.4	10.4								204	11
Fish						2.0	2.6	9.0	19.8	85.0	17	7
Decapoda						2.9	2.8	4.7			3	3
Ostracoda	1.6	0.5	0.1	0.5	2.2	0.3	0.1	<0.1			70	30
Fish scales								4.3	8.0		4	2
Amphiba							2.9				1	1
Plant material		<1.7					0.4	0.6			12	10
Rotifera	<0.1										10	1
Arachnida				<0.1				<0.1			5	2
Total Other	1.7	6.6	10.5	0.6	2.2	5.2	8.8	18.8	27.8	85.0	326	67

TABLE 4.
Average frequency of occurrence of each food organism by standard length class of fish.

Item Eaten	*10-19mm*	*20-29mm*	*30-39mm*	*40-49mm*	*50-59mm*	*60-69mm*	*70-79mm*	*80-89mm*	*90-99mm*	*100-110mm*
Cladocera										
Diaphanosoma	25.0	10.0	18.0	27.3	69.2	65.7	50.0	52.4	20.0	
Moina	5.0	23.3	38.5	40.9	38.5	14.3	11.8	4.8		
Ceriodaphnia		5.0	12.8	31.8	19.2	14.3	11.8	9.5		
Alona		18.3	15.4	4.5						
Simocephalus				4.5	15.4	14.3	20.6			
Daphnia	3.3	6.7	10.3			2.9	8.8	4.8		
Bosmina		5.0	12.8	22.7	3.8		2.9			
Macrothrix		5.0	2.6							
Unid. Clad.	6.7	1.7		4.5	3.8					
Total Clad.	33.3	50.0	64.1	81.8	92.3	82.9	70.6	61.9	20.0	
Copepoda										
Diaptomus	55.0	51.7	60.0	59.1	80.1	42.9	23.5	14.3		
Cyclops	3.3	18.3	15.4	9.1	7.7	11.4	2.9			
Nauplii	11.7	13.3								
Unid. Cop.	10.0	6.7		4.5		5.7				
Total Cop.	66.7	83.3	71.8	68.2	80.8	57.1	29.4	14.3		
Insecta										
Chironomidae	10.0	46.7	30.8	40.9	23.1	11.4	17.6	19.0		
Odonata			7.7	27.3	3.8	14.3	32.4	19.0		50.0
Ephemeroptera		16.7	18.0	22.7	23.1	25.7	20.6	9.5		
Notonectidae					15.4	20.0	17.6	14.3		
Culicidae	26.7	3.3	2.1	13.6	15.4					
Trichoptera						11.4	5.9	23.8	20.0	
Corixidae			7.7				8.8	4.8	20.0	
Ceratopogonidae			5.1	4.5		8.6	2.9			
Unid. Insects			12.8	9.1	11.5	8.6	8.8	9.5	40.0	
Total Insects	33.3	53.3	61.5	59.1	57.7	68.6	70.6	71.4	80.0	50.0
Annelida		6.7	18.0							
Fish						2.9	2.9	33.3	40.0	100.0
Decapoda						2.9	2.9	4.8		
Ostracoda	1.7	13.3	7.7	22.7	15.4	11.4	11.8	4.8		
Amphiba							2.9			
Rotifera	1.7									
Arachnida				4.5				4.8		
Plant Material		1.7					11.8	9.5		
No. Stomachs	68	62	39	26	29	38	42	25	5	2
No. Stomachs with Food	60	60	39	22	26	35	34	21	5	2

TABLE 5.
Average percent total number of each food organism by standard length class of fish.

Item Eaten	*10-19mm*	*20-29mm*	*30-39mm*	*40-49mm*	*50-59mm*	*60-69mm*	*70-79mm*	*80-89mm*	*90-99mm*	*100-109mm*
Cladocera										
Diaphanosoma	19.9	5.4	17.1	26.1	53.0	82.0	68.4	90.2	91.6	
Moina	3.0	6.9	44.5	35.3	14.1	7.1	15.5	4.4		
Ceriodaphnia		1.7	6.2	23.8	11.5	4.6	5.7			
Alona		1.4	3.6							
Simocephalus				0.4	4.7	0.9	1.7			
Daphnia	1.3	0.2	1.3			Trace	5.4	1.7		
Bosmina		4.6	1.0	2.3	0.1					
Macrothrix		4.4	Trace							
Unid. Clad.	1.3	Trace		0.2	Trace					
Total Clad.	25.5	24.6	73.7	88.5	83.4	94.6	96.7	96.3	91.6	
Copepoda										
Diaptomus	54.7	17.0	16.9	4.6	15.0	3.6	0.9	0.3		
Cyclops	0.5	13.7	4.9	4.6	0.3	Trace	0.3			
Nauplii	4.6	36.7								
Unid. Cop.	3.2	7.0		0.2		<0.1				
Total Cop.	63.1	74.4	21.8	9.4	15.3	3.7	1.2	0.3		
Insecta										
Chironomidae	2.8		0.7	1.2	Trace	0.3	0.5	1.2		
Odonata			Trace	0.4	Trace	0.2	0.3	0.2		33.3
Ephemeroptera		0.3	0.2	0.1	0.4	0.4	0.4	<0.1		
Notonectidae					0.1	0.2	0.5	0.4		
Culicidae	5.3	0.1	Trace	0.1	Trace					
Trichoptera						0.6	0.2	0.8	5.5	
Corixidae			0.1				0.1	0.3	0.7	
Ceratopogonidae			0.1	Trace		0.1	Trace	0.2		
Unid. Insects			0.3	Trace	<0.1	Trace	Trace	Trace	1.1	
Total Insects	8.1	0.4	1.4	1.8	0.6	1.8	3.2	3.2	7.3	33.3
Annelida			2.9							
Fish						Trace	Trace	0.2	1.1	66.6
Decapoda						Trace				
Ostracoda	0.8	0.2	0.2	0.1	0.4	Trace	Trace	Trace		
Amphiba							Trace			
Plant Material		Trace					Trace	0.1		
Rotifera	2.5									
Arachnida				0.5				Trace		
Total Other	3.3	0.2	3.1	0.6	0.4			0.3	1.1	

insects were represented in the samples. The importance of any one species varies with the season and/or length class of fish. In the 10 mm. to 19 mm. length class the culicid *Chaoborus* sp. was an important food comprising fourteen percent of the total estimated volume and occurring in 26.7 percent of the stomachs examined.

Fish as food first occurred in the 60 mm. to 69 mm. class but was not important until the stripedbass reached 100 mm. *Dorosoma cepedianum, Pimephales promelas, Gambusia affinis* and *Notropis lutrensis* were the species recovered from the stomach samples. *Tilapia* sp. and *Lepomis* sp. were present but none were utilized by bass in this study.

Only three stomachs (from fish in the 70 mm. to 79 mm. class) contained commercial fish food although it was available in fifteen ponds. These three stomachs contained no natural food and were treated as empty in all calculations.

Rotifers were of no importance in volume, number or frequency of occurrence in the samples. Only one fish was found utilizing rotifers in the study.

Benthic organisms, although abundant, were utilized very little.

The average bass in this study ingested, by volume, 31.4 percent cladocera, 25.2 percent copepods, 36.3 percent insects and 7.3 percent other.

DISCUSSION

Striped bass and the largemouth bass *(Micropterus salmoides)*, a commonly cultured warm water species, are both carnivorous. Therefore, it is of interest to compare their food habits. Murphy (1949) states that after the largemouth bass attains a length of 40 mm. total length (approximately 30 mm. standard length) their diet changes from predominately cladocerens and copepods to one of insect larvae. At 65 mm. to 75 mm. total length (approximately 50 mm. to 60 mm. standard length) fish become the most important item in their diet (Davis, 1953). No information was available on any preference of copepods over cladocerens.

Striped bass, because of their smaller mouth size to body length ratio, apparently select copepods from the available food until they reach 30 mm. standard length. At this time cladocerens and various insect larvae become equally represented by volume. When striped bass attain 80 mm. standard length insect larvae have become the predominant item by volume in the diet although cladocerens are still the most abundant by number. Fish occur first in stomachs of bass in the 60 mm. to 69 mm. length class, but do not become important until the striped bass reach 100 mm. At this time fish in the diet become predominate over all other items. Adequate numbers of very small forage fish were available in the ponds throughout the study.

CONCLUSIONS

From the information obtained in this study it would appear desirable to culture striped bass in a manner similar to that used for largemouth bass. However, due to the relatively small mouth size of striped bass, addition of forage species should be delayed until the bass are four to five inches in length. Early addition of forage species would produce competition for available food. When forage is introduced it appears desirable to provide soft rayed fish of fusiform body shape rather than laterally compressed or spiny rayed species.

A program of pond management to provide an abundance of copepods early in the season and cladocerens and insect larvae late in the season will provide striped bass with an adequate food supply

Although one-half of the ponds in the study had commercial fish food introduced daily, only three stomachs were found to contain this item. In striped bass ponds not included in the study, feeding activity was observed and a high percentage of striped bass fingerlings were harvested from the ponds. Apparently the addition of prepared diets to striped bass ponds, without visual observations of feeding activity, is not helpful in providing an additional food source.

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SOME PROGRESS IN THE CONTROLLED CULTURE OF THE LARGEMOUTH BASS, *MICROPTERUS SALMOIDES*, (Lac.)[1]

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INTRODUCTION

More than 19 million largemouth bass, *Micropterus salmoides* (Lacepede), fingerlings were produced and distributed by federal fish hatcheries in 1967[2]. If state hatchery production were added to this total, the number supplied by public hatcheries is estimated to be well over 42 million. This estimate is based on the findings of Hagen and O'Conner (1958) who reported a ratio of state to federal bass production of 1.22 to 1.0. Largemouth bass are included in practically all of the 30,000 to 40,000 farm ponds stocked annually by the Bureau of Sport Fisheries and Wildlife (King, 1960). In the southeast, only the bluegill sunfish, *Lepomis macrochirus*, Rafinesque, approaches the largemouth bass in importance numerically, and the fact that more bluegills are distributed than bass is explained by the greater number stocked per acre rather than that more acres receive bluegills than bass.

There was a steady upward trend noted in the number of bass distributed by federal hatcheries during three decades starting in 1940 which reached a peak about 1965. Available information suggests that this high rate of demand can be expected

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[2]Annual Report - 1967. Division of Fish Hatcheries, U. S. Dept. of Interior, Bureau of Sport Fisheries and Wildlife, Washington, D. C.