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THREADFIN SHAD, *DOROSOMA PETENENSE*, AS FOOD OF YEARLING CENTRARCHIDS[1]

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INTRODUCTION

The purpose of this paper is to report an apparent failure of threadfin shad to provide adequate forage for yearling largemouth bass, *Micropterus salmoides*, and black crappie, *Pomoxis nigromaculatus*, in a 50-acre fishing impoundment.

Pena Blanca Lake, the site of the fishery under discussion, is in Santa Cruz County, Arizona. It has been described previously (McConnell, 1963; Gerdes and McConnell, 1963). Shad, bass, and crappie were stocked when the impoundment first filled in the spring of 1958. Food habits and spawning of the shad in Pena Blanca Lake have been reported (Gerdes and McConnell, 1963).

METHODS

The centrarchids were captured by angling, electrofishing, and gill netting, primarily during the summer (Table 1). Fish near the length modes of collections were selected when an entire collection was not used in the analysis (1961 only). Length frequencies indicate that most of the fish studied were near the end of their first year of life or in their second (McConnell, 1963). The modal groups formed by yearlings dominated the centrarchid population in all years but 1960, when young-of-the-year largemouth bass were preponderant. Volume of shad consumed is reported as the reconstructed pre-ingestion volume. Reconstruction was based upon the relationship of volume to the combined length of the five caudal vertebrae preceding the hypural plate (Figure 1). Caudal vertebrae of shad, easily distinguished from those of other

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TABLE 1

Month and Method of Collecting Centrarchids and Number of Stomachs Examined *

Species	Year	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.
Largemouth bass	1959	7,T	5,T		23,H	7,H	3,H			
Largemouth bass	1960					1,T	10,T		4,T	10,E
Largemouth bass	1961		10,E		20,H	21,H	12,H	10,H		
Black crappie	1960					1,T	21,T		2,T	9,E
Black crappie	1961			10,T	22,H	16,H	14,H	7,H		

* T = throw net; H = hook and line; E = electrofishing.

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fish in Pena Blanca Lake, were frequently all that remained for identification. Volume of arthropods was determined as the settled volume in a graduated centrifuge tube. Settled volume, including interstices, probably is a closer approximation of pre-ingestion volume than volume of water displaced when exoskeletons are the principal remains.

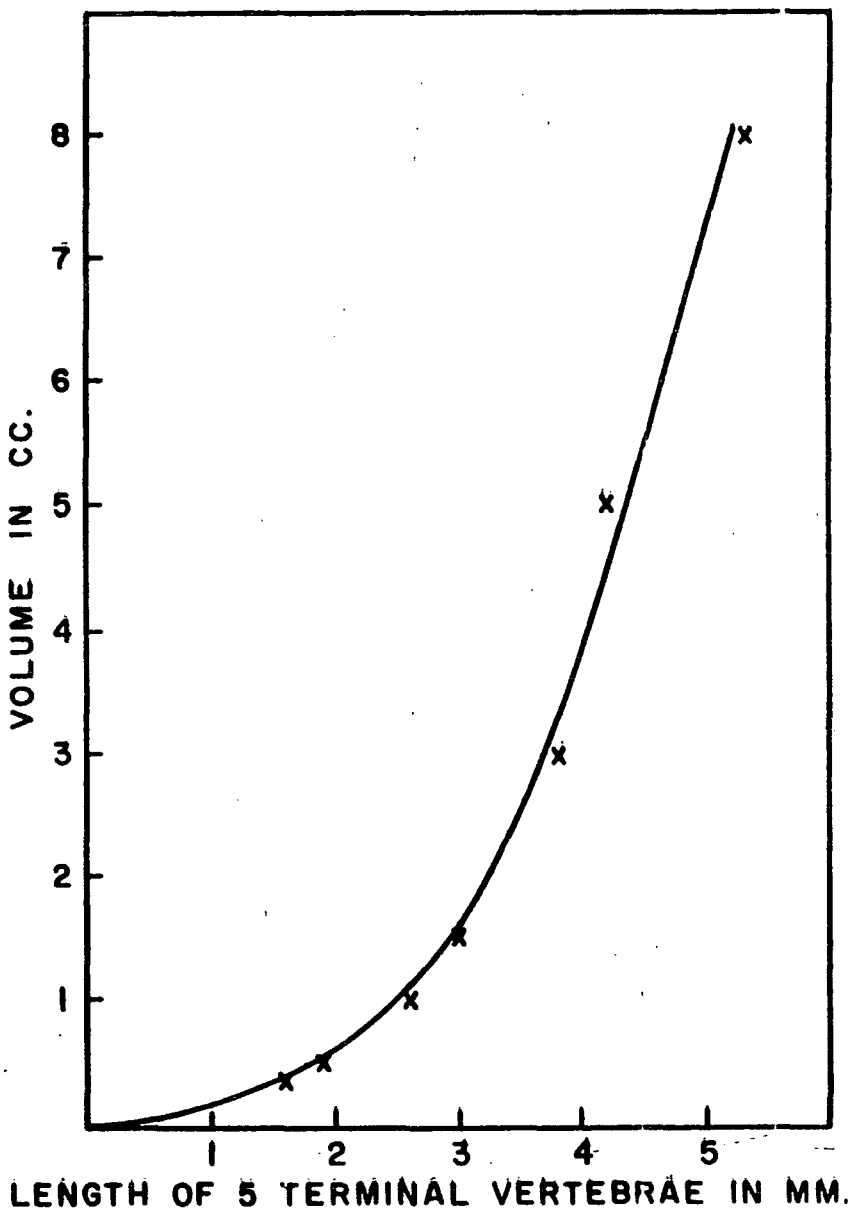

FIGURE 1. Relationship of volume to length of 5 terminal vertebrae of 7 threadfin shad. The curve was fitted by eye.

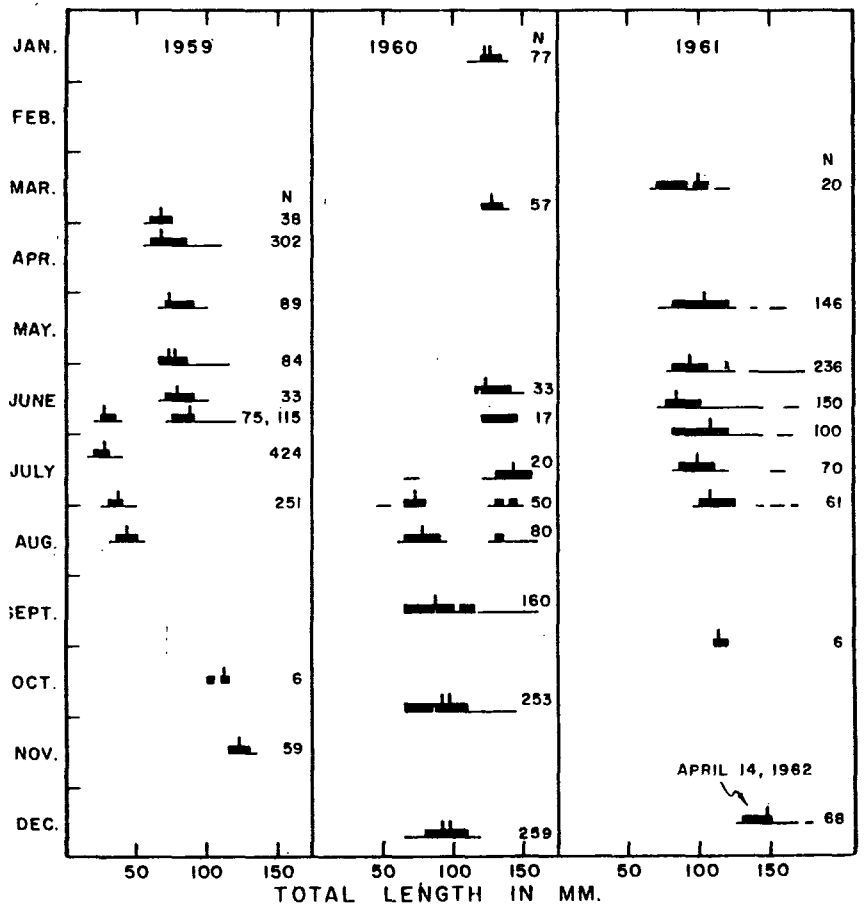

FIGURE 2. Length frequencies of threadfin shad in Pena Blanca Lake. The width of the rectangles represents the range of total lengths including 80 percent of samples, the horizontal lines extending from the bases of rectangles represent the total range of lengths, and vertical dashes indicate the positions of modal 5 mm length groups. *Column under* N *indicates* sample size.

Numbers of shad used in the length frequency analysis, and time and method of capture are shown (Figure 2). The absence of shad under 50 mm (total length) in collections between mid-August and mid-June of the following spring was corroborated by extensive observation. Whenever small shad were collected in gill nets, they were also seen shortly before or after the day of capture.

FOOD HABITS

Arthropods (cladocerans and insects) occurred much more frequently than shad in the diet of yearling centrarchids in Pena Blanca Lake (Table 2). The relatively few shad eaten contributed an important increment to the total volume of food consumed, but were still second to arthropods by this criterion. Murphy (1949) found that both volume

TABLE 2

Major Centrarchid Foods in Pena Blanca Lake

Species	Year	Stomachs examined	Total length range (mm)	Threadfin shad			Cladocerans		Insects		Number empty
				Percent vol.	Percent occ.	No.	Percent vol.	Percent occ.	Percent vol.	Percent occ.	
Largemouth bass	1959	45	116-120	--	13.0	20	--	9	--	66	11
Largemouth bass	1960	25	85-128	40	8.0	4	21	32	38	75	4
Largemouth bass	1961	73	109-195	27	1.4	1	25	41	47	74	5
Black crappie	1960	32	71-147	35	1.5	8	49	62	15	60	6
Black crappie	1961	68	135-198	0.0	0.0	0	78	84	22	72	4
All centrarchids	1959-61	243	76-200	--	5.8	33	--	49	--	60	30

and numbers of fish greatly exceeded those of arthropods in the diet of 3.5- to 5-inch largemouth bass in Clear Lake, California. Kutkuhn (1955) and Reid (1950) presented similar findings for black crappie over 4 inches TL.

Largemouth bass between 2.5 and 5 inches in Clear Lake were found by Murphy (1949) to contain an average volume of 0.39 cc of fish each. Largemouth bass from Pena Blanca Lake in the same size range contained an average volume of all foods of only 0.27 cc. This comparison suggests that largemouth bass in Pena Blanca Lake were deprived of an important increment of food by the unavailability of small forage fish.

Length frequencies of shad provide a possible explanation for their relative scarcity in the diet of yearling centrarchids (Figure 2). During the three years of study no shad under 50 mm TL were observed or collected during the spring or during September and October. Therefore, during at least 5 of the 8 months with water temperatures above 60° F., yearling centrarchids probably had difficulty finding fish they could eat. Stomach samples indicated that shad which exceeded half the length of the centrarchid predator were not often eaten successfully (Table 3). Several unverified reports were received of bass dying while attempting to eat large shad. One dead bass, with a shad lodged in its throat, was found by a fisherman and given to project personnel (Table 3). Examination revealed the shad could not be regurgitated because of its belly scutes.

The principal causes of small shad scarcity in Pena Blanca Lake are apparently a single, short spawning period and subsequent rapid growth of young-of-the-year (Figure 2). Shad in Pena Blanca Lake did not spawn before mid-May in 1959, 1960, and 1961 (Gerdes and McConnell, 1963). Most spawning was completed by early July in 1961 and presumably in 1959 and 1960. No evidence of later spawning by young-of-the-year was detected during 1959, 1960, and 1961. But length frequency modes (60-80 mm) during the spring of 1959 suggested late spawning in 1958 by young-of-the-year. Kimsey et al. (1957) reported spawning by shad-of-the-year in California.

TABLE 3

Predator-Prey Length Relationship of Centrarchids and Threadfin Shad

Predator	Date	Number eaten	Total length of predator (mm)	Total length of prey (mm)	Length ratio prey/predator
Largemouth bass	March 28, 1959	1	200	not meas.	not det'd.
Largemouth bass	June 6, 1959	1	177	not meas.	not det'd.
Largemouth bass	June 6, 1959	1	177	not meas.	not det'd.
Largemouth bass	June 6, 1959	1	177	not meas.	not det'd.
Largemouth bass	June 24, 1959	1	177	not meas.	not det'd.
Largemouth bass	July 10, 1959	15	183	all <50	all <0.27
Largemouth bass	July 7, 1960	1	107	50	0.47
Largemouth bass	Aug. 3, 1960	3	109	47, 46, 40	0.43, 0.42, 0.37
Largemouth bass	Aug. 8, 1961	1	187	98	0.51
Largemouth bass	Unknown	1 (attempted)*	178	103	0.57
Black crappie	Aug. 3, 1960	4	80	31, 36, 31, 31	0.39, 0.45, 0.39, 0.39
Black crappie	Aug. 3, 1960	1	82	40	0.49
Black crappie	Aug. 3, 1960	1	84	31	0.37
Black crappie	Aug. 15, 1960	1	98	50	0.51
Black crappie	Aug. 15, 1960	1	105	36	0.34
Totals		34			

* The largemouth bass died when a threadfin shad became stuck in its throat.

Shad-of-the-year usually attain sexual maturity, but do not ripen, by late October in Pena Blanca Lake. Apparently ripeness is impaired by prevailing temperatures under 65° F. from early November through April. January water temperatures as low as 42° F. in Pena Blanca Lake may also inhibit early ripening in the spring.

Extensive observation supported the absence of shad-of-the-year in 1961 collections (Figure 2). In 1959 and 1960, abundant young-of-the-year were very obvious from late June to early August even when temporarily difficult to collect. This was not true in 1961. Although spawning was extensive, no young were detected in the lake. Eggs returned to the laboratory in 1961 hatched successfully, indicating some other factor was responsible for the year-class failure. Gill-netting in April 1962 supported observations of no survival from the 1961 year-class (Figure 1). Meteorological and limnological conditions (including insolation, wind, inflow, p^H, T.D.S., primary productivity, light penetration, dissolved oxygen, and stratification) in 1959 and 1960 were similar in 1961. The only major difference existed in the fish population. For the first time there was a large population of yearling black crappie, and the adult shad population was much greater than it had been in previous springs. Possibly, predation on larvae by either of these groups was more intensive than usual, and eliminated the year-class.

In addition to failing to provide forage for yearling centrarchids, there is evidence that shad may compete with centrarchids for cladocerans. Gerdes and McConnell (1963) found that cladocerans were preponderant in the diet of shad in Pena Blanca Lake. Large numbers of adult shad occurred there throughout the study.

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SUMMARY

During a 3-year study, stomachs of 143 largemouth bass and 100 black crappie between 75 mm and 200 mm (TL) revealed that occurrence of threadfin shad never exceeded 13 percent for either species. Although important in total volume of food consumed, shad were outranked by arthropods in the diets of both centrarchids in 1960 and 1961. In volume threadfin shad averaged 33 percent of the largemouth bass diet and 17 percent of the crappie diet during these years. Arthropods, mainly cladocerans and insects, made up the remainder of the diets. Rapid growth of threadfin shad after one short spawning period in late spring was postulated as a probable reason for their infrequent use as food by yearling centrarchids. Failure of the shad to produce a year-class in 1961 was also important.

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